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Breast Arterial Calcifications on Mammography: A Review of the Literature

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Abstract

Identifying systemic disease with medical imaging studies may improve population health outcomes. Although the pathogenesis of peripheral arterial calcification and coronary artery calcification differ, breast arterial calcification (BAC) on mammography is associated with cardiovascular disease (CVD), a leading cause of death in women. While professional society guidelines on the reporting or management of BAC have not yet been established, and assessment and quantification methods are not yet standardized, the value of reporting BAC is being considered internationally as a possible indicator of subclinical CVD. Furthermore, artificial intelligence (AI) models are being developed to identify and quantify BAC on mammography, as well as to predict the risk of CVD. This review outlines studies evaluating the association of BAC and CVD, introduces the role of preventative cardiology in clinical management, discusses reasons to consider reporting BAC, acknowledges current knowledge gaps and barriers to assessing and reporting calcifications, and provides examples of how AI can be utilized to measure BAC and contribute to cardiovascular risk assessment. Ultimately, reporting BAC on mammography might facilitate earlier mitigation of cardiovascular risk factors in asymptomatic women.

Key words: breast arterial calcifications; cardiovascular disease; coronary artery disease; artificial intelligence; mammography.

Introduction

Heart disease is the most common cause of death in the United States[1,2] and in industrialized and developing nations worldwide.[3] For women ≥35 years of age in the United States from 1999 to 2020, there were approximately 10 times more deaths from cardiovascular disease (CVD) than breast cancer (9 475 180 deaths from CVD and 900 781 breast cancer deaths).[4] Despite these statistics, awareness of CVD as the leading cause of women's death declined from 2009 to 2019.[5]

This review outlines studies evaluating the association of breast arterial calcification (BAC) and CVD, introduces the role of preventative cardiology in clinical management,

Key Messages

- Evidence from observational studies suggests that mammographic breast arterial calcification (BAC) has an association with cardiovascular disease (CVD) in women and might be an indicator of subclinical CVD.
- Assessment and reporting of BAC on mammography are varied and inconsistent, which is a barrier to defining the relationship of BAC and cardiovascular outcomes in women.
- Artificial intelligence may be leveraged to standardize reporting of BAC to facilitate future research and optimize clinical workflows.

discusses reasons to consider reporting BAC, acknowledges current knowledge gaps and barriers to assessing and reporting calcifications, and provides examples of how artificial intelligence (AI) can be utilized to measure BAC and contribute to cardiovascular (CV) risk assessment.

Breast arterial calcifications and CVD

Screening mammography is currently recommended annually starting at the age of 40 years in women with an average lifetime risk of breast cancer[6,7] and earlier than age 40 years in some women with elevated breast cancer risk.[8] Breast arterial calcifications are present on approximately 12% to 23% of screening mammograms[9-11] and have associations with diabetes, coronary artery calcifications (CACs), coronary artery disease (CAD), peripheral vascular disease, and cerebral vascular accident (CVA) as well as CV mortality.[12] Breast arterial calcifications occur within the media (middle) layer of the vessel wall, and atherosclerotic CACs typically originate in the vascular intima; although not directly involved in the pathogenesis of coronary artery atherosclerosis, medial arterial calcifications in the systemic circulation can decrease vascular compliance, increase afterload and left ventricular hypertrophy, alter coronary artery perfusion, and ultimately contribute to episodes of myocardial infarction (MI) and ischemia.[13]

The majority of studies evaluating the relationship of BAC and CVD demonstrate positive, statistically significant associations with CACs,[14-21] CAD,[11,21-33] and atherosclerotic CVD (ASCVD).[33-37] Studies demonstrating no association between BAC and CACs[36,38] or CAD[39-43] are fewer in number and usually have smaller sample sizes. Recent data show positive associations with BACs and CACs, CAD, or CVD.[11,44-53]

A large retrospective analysis of >18 000 women published in 2024 evaluated the relationship of BAC with outcomes of mortality and composite measures of CVD.[11] Subgroup analyses incorporated other pertinent variables, including age, race, blood pressure, diabetes, smoking, cholesterol, CVD history, and chronic kidney disease. Investigators used a validated proprietary currently Food and Drug Administration–approved software (cmAngio by CureMetrix, San Diego, CA) derived from a neural AI network to measure BAC as a binary variable (presence or absence), as a continuous variable (BAC score from 0-100), and as 1 of 4 quartile groups. When compared with women without BAC on mammography, women with BAC had increased mortality and a greater composite number of CVD events (ie, MI, heart failure, CVA, and mortality) with a median follow-up of 4.8 and 4.3 years, respectively. This difference persisted on multivariable analysis. When BAC was measured and analyzed as a continuous variable scored from 0 to 100, increased BAC score in 10-point increments was independently associated with a greater risk of mortality and CVD events (P <.001). When stratified by age, Kaplan-Meier curves showed a significant difference between mortality and the CVD composite outcome between those with and without BAC for women aged 40 to 59 years and 60 to 74 years and not for women 75 to 90 years of age. Additionally, after controlling for conventional risk factors, those aged 40 to 59 years had the highest residual risk associated with BAC, with persistent increased risk of mortality and CVD composite events for those aged 60 to 74 years (and not for those ≥75 years old).

Three applicable systematic reviews with meta-analyses evaluating the association of BAC and CVD have been published within the past 10 years (Table 1). Hendriks et al[9] evaluated various combinations of 52 studies from 1984 through 2014 and discovered that BAC prevalence increases with each decade of age, diabetes mellitus (DM), and parity vs nulliparity. These authors found no significant pooled association between BAC and hypertension (HTN), hyperlipidemia, or body mass index. No pooled effect size could be calculated for BAC as a CV risk factor because of study differences; however, individual cohort studies in their review did show significant associations with BAC and CV death; BAC and CAD and heart failure; and BAC and incident CV disease. These authors concluded that BAC is associated with CV disease and some CV risk factors, with the caveat that longitudinal data are sparse.

In a recently published systematic review and meta-analysis of 5 observational cohort studies, Koh et al evaluated the association between BAC and CVD with a combined cohort of 87 865 patients.[56] Koh et al concluded that BAC demonstrated a statistically significant positive association with increased cardiac mortality; however, this analysis included data from a study with 57 867 patients that counted groups of suspicious microcalcifications identified by a computer-aided detection system rather than specifically assessing BAC.[57] Therefore, the internal validity and generalizability of this data are difficult to contextualize.

Recent meta-analyses of predominantly cross-sectional or case control studies also found significant associations of BAC and CAD[54,55] as well as BAC and HTN and DM.[55] Osman et al[54] suggested that BAC may be a noninvasive

Table 1. Summary of Systematic Reviews and Meta-analyses of BACs

Systematic review and meta-analysis	Outcome (total studies analyzed)	Notable study features	Total participants	Method of BAC assessment	Results summary	Conclusions
Osman et al[54]	Association between BAC and CAD (18)	All observational. Majority are cross-sectional or case control.	33 494	Twelve studies identified only presence or absence of BAC. Three used a grading system only. Three used both a grading system and reported presence or absence of BAC.	Significant association of BAC and CAD (unadjusted OR, 2.14; 95% CI, 1.63-2.81; *P*<.001). In 10 studies, BAC independently predicted CAD (adjusted OR, 2.39; 95% CI, 1.68-3.41; *P*<.001).	BAC may be a noninvasive imaging marker for CAD prediction in women. Further evaluation is needed with large prospective studies.
Lee et al[55]	Association between BAC and CAD, as well as risk factors for CAD (31)	Three longitudinal; 28 cross-sectional	35 583	Nineteen studies identified only presence or absence of BAC. Twelve used a grading system.	Significant association of BAC and CAD (OR, 2.61; 95% CI, 2.12-3.21). Association of BAC and CAD still significant when stratified by method of BAC reporting by presence or absence (OR, 2.05; 95% CI, 1.70-2.47) vs grading (OR, 4.04; 95% CI, 2.59-6.30). Subanalysis of studies using either a 4- or 12-point grading system for BAC showed associations of moderate to severe BAC and CAD but not mild BAC. Breast arterial calcification is associated with CAD, HTN, and DM.	Future studies would optimally exclude patients with known CAD/CVD and have a prospective design. Consensus is needed for BAC quantitation method.

Table 1. Continued

Systematic review and meta-analysis	Outcome (total studies analyzed)	Notable study features	Total participants	Method of BAC assessment	Results summary	Conclusions
Hendriks et al[9]	Association of BAC with CV risk factors and CV risk (52 studies with various population subcategories—general, postmenopausal, CKD, DM)	Only 5 prospectively reported CVD	Not reported	All studies reported the presence/absence of BAC.	Breast arterial calcification prevalence increases with age, DM, and parity (OR, 2.98 [95% CI, 2.31-3.85] for every 10 y; OR, 1.88 [95% CI, 1.36-2.59]; OR, 3.43 [95% CI 2.23-5.27]; respectively). No significant pooled association found between BAC and HTN, hyperlipidemia, or BMI. No pooled effect size was calculated for BAC as a CV risk factor because of study differences; individual cohort studies did show significant associations with BAC and CV death, BAC and CAD and heart failure, and BAC and incident CV disease.	Breast arterial calcifications appear to be associated with CVD and some CV risk factors with the caveat that longitudinal data are sparse.

Abbreviations: BAC, breast arterial calcification; BMI, body mass index; CAD, coronary artery disease; CKD, chronic kidney disease; CV, cardiovascular; CVD, CV disease; DM, diabetes mellitus; HTN, hypertension; OR, odds ratio.

imaging marker for CAD prediction in women, and Lee et al[55] concluded that future studies would optimally exclude patients with known CAD/CVD to better evaluate how well BAC severity might predict CV events. Authors from both analyses also advocated additional prospective studies.

In a recent prospective cohort study ($N = 1039$) from the United States with 10 years of follow-up data (the longest known duration of prospective follow-up for studies evaluating BAC and subsequent CVD), women with incidental BAC on screening mammography were more likely to have CAD and cerebrovascular events than those without BAC when controlling for age.[58] In a retrospective cohort study of patients with breast cancer with 23 years of follow-up, women with BAC demonstrated a statistically significant increased risk of CV events and heart disease vs women without BAC with similar mean age, and BAC was independently associated with shorter CV event–free survival and CV event–specific survival times ($P < .0001$).[59]

The Multiethnic Study of Breast Arterial Calcium Gradation and Cardiovascular Disease (MINERVA) observational prospective cohort study of >5000 postmenopausal female members undergoing routine screening mammography in Kaiser Permanente of Northern California evaluated the association of CVD and BAC as well as the effect of BAC on risk equations for atherosclerotic CVD.[53] The average length of follow-up time for cohort participants was 6.5 years (SD, 1.6 years). In this study, even when controlling for established CV risk factors, the presence of BAC was not only associated with greater risk of acute MI, ischemic stroke, or death from CVD but also was also associated with an increased risk of global CVD, such as cardiomyopathy, venous thromboembolic disease, peripheral arterial disease, and death from CVD. In addition, adding the presence or absence of BAC to CVD risk calculation improved risk reclassification for CVD ($P < .05$).

In summary, many observational studies (retrospective, prospective, and cross-sectional analyses) demonstrate positive associations with CAD and other CV risk factors as well as other CVD outcomes. More prospective, longitudinal studies with longer follow-up intervals evaluating BAC and CVD outcomes would be helpful to augment the growing body of evidence linking BAC with CVD risk and adverse CVD events. Additional research is needed to clarify how the associations of BAC and CVD outcomes vary by age to additionally guide BAC reporting and to further define the clinical ramifications of BAC findings.

Preventative cardiology and BAC

The association of BAC and CVD also depends on the presence of CV risk factors, such as age, HTN, and diabetes.[60] Preventative cardiology intends to mitigate the development of cardiac risk factors (primordial prevention), initial episodes of CVD (primary prevention), and subsequent CV events (secondary prevention) to improve individual and population health outcomes.[61] Preventative cardiology also advocates CV risk reduction, which has successfully decreased both major adverse cardiac events and mortality from CVD.[62-65]

The earliest assessment method of estimating multivariable risk of developing coronary heart disease was the Framingham risk assessment model, which used logistic regression and incorporated age, serum cholesterol, systolic blood pressure, relative weight, hemoglobin, cigarette smoking, and electrocardiogram findings to predict the probability of developing coronary heart disease in a 12-year period.[66] Currently, the American Society for Preventative Cardiology endorses the Pooled Cohort Equations (PCE) to calculate 10-year and lifetime risk of ASCVD for patients without known heart disease or hypercholesterolemia using risk factors such as age, biological sex, systolic blood pressure, antihypertensive treatment, cholesterol (total and high-density lipoprotein), diabetes, cigarette smoking, and Black race.[67] Notably, the 10-year risk of ASCVD is categorized as low (<5%), borderline (5%-7.5%), intermediate (7.5%-20%), or high (≥20%) and can be utilized in the context of other known risk factors to determine the value of risk-reducing treatments for an individual patient.[67]

Detection and reporting of BAC on screening mammography might facilitate preventative cardiology by identifying patients who are asymptomatic and could benefit from cardiac risk reduction efforts. In patients who are asymptomatic, CAC on CT is currently considered an indication of possible subclinical heart disease, and cardiologists may use CAC scores to justify initiating preventative strategies, including aspirin, statins, and modifications of diet and physical activity levels.[68] Breast arterial calcification has been retrospectively shown to have independent positive associations with the progression of CAC and coronary arterial plaque.[21] In a retrospective cross-sectional study of 10 years of data, women with both BAC and CAC and BAC alone had an estimated 10-year risk of ASCVD in the intermediate category (13.3% and 8.8%, respectively), while those without BAC or CAC had a 10-year risk of ASCVD in the low category (4.4%).[36]

Why report BAC?

The current version of the *Breast Imaging Reporting and Data System (BI-RADS) Atlas* (5th edition from 2013) does not require reporting of typically benign calcifications and does not provide guidance regarding reporting vascular calcifications.[69] A prior version of the *Atlas* (4th edition from 2003) also provided no specific guidance for reporting of vascular arterial calcifications but did cite data that vascular calcifications in women <50 years of age may indicate a possible risk of CAD.[70] A recent retrospective review of BAC and CAC found that BAC had the highest diagnostic accuracy for CAC in women aged <60 years (93.2% for the detection of women with marked CAC).[20]

Reporting BAC on routine screening mammography may present an opportunity to use existing medical imaging data to prompt CV risk assessment and reduce morbidity and/or mortality from CVD in various clinical settings in patients without known CVD. For example, patients with BAC may have subclinical disease or require clinical evaluation for CV symptoms not yet evaluated by an internist, cardiologist, or applicable care provider. Among those without existing ASCVD, it is estimated that approximately two-thirds of patients will have a low risk of ASCVD, one-fourth will have an intermediate risk of ASCVD, and the remainder will have a high risk using the PCE 10-year risk for ASCVD based on NHANES (The National Health and Nutrition Examination Survey) data.[71] A notable number of CV events may still occur in women with low 10-year ASCVD risk calculated by PCE.[72] Additionally, adults without established risk factors for CVD, such as smoking, HTN, or hypercholesterolemia, with a 10-year ASCVD risk of ≥7.5% still may have a high ASCVD incidence.[73]

Like CAC,[72] BAC might augment existing prediction methods for ASCVD events. In a retrospective review of ~300 patients who were asymptomatic without known CAD, BAC was equivalent to the Framingham Risk Score and PCE.[16] When including patients with ($n = 292$) and without ($n = 33$) known CAD, incorporating BAC data increased the area under the receiver operating characteristic (ROC) curve for the Framingham Risk Score and PCE risk calculations with an incremental change that was statistically significant.[16]

Moreover, reporting BAC may have other applications for specific patient populations. In a retrospective analysis of patients diagnosed with breast cancer, BAC predicted shorter overall survival primarily due to death related to CVD,[74] which may have implications for therapeutic approaches in oncology. With relevance to populations with health disparities, a recent retrospective analysis of >14 000 women aged >40 years reported that the presence of BAC predicted greater all-cause mortality for all racial/ethnic groups but was more likely to predict mortality in Black vs White women.[75]

Reporting BAC

In a patient survey at a single institution in the United States, 96% of patients preferred BAC reporting, and 77% expressed a preference for notification of BAC by lay letter or telephone call.[76] A multi-institutional survey of 227 women who were asked to review a hypothetical lay letter informing patients about negative mammography results and the presence of BAC on their mammograms demonstrated that most women accurately recalled the information about BAC presented in the letter and reported a strong intention to follow up with a health care provider about their CV health.[77] However, the respondents in this study reported high levels of education, and ~90% were White. More research is needed to elucidate effective information content and communication strategies for reporting the presence of BAC on mammography to patients.

Among recently surveyed radiologists in the United States,[78] Canada,[79,80] and Europe,[81] there was no consensus in support of or against reporting BAC on screening mammography or recommending clinical follow-up for BAC. If BAC was reported, the method of reporting varied in those surveys, with some radiologists qualitatively describing the presence or absence of BAC, while others used a grading system to indicate the severity of BAC. In a survey of practicing radiologists who were members of the Society of Breast Imaging, the majority of radiologists acknowledged that there is increasing evidence of an association with BAC and CAD, but only 15% of respondents affirmed reporting the presence of BAC, and <1% of respondents indicated that they consistently issue follow-up recommendations.[82]

Clinical impact of reporting

A recent study by Vincoff et al[83] published in the *Journal of Breast Imaging* begins to address the question of burden and value. Sixty-eight of the 494 women studied (13.8%) had BAC. Of note, only patients with BAC were offered a survey. Of these 68 patients, 42 (61.8%) responded to a survey after mammography. Twenty-four of the 42 (57%) followed up either with a cardiologist or primary care physician. Testing included 14% with cardiac stress tests; 31% with echocardiography; 19% with a CV US, CT, or MRI; and 7% with a coronary angiogram. One of 42 respondents (2%) underwent a cardiac procedure or surgery. Reporting BAC in this small study likely did not result in reflexive orders for cardiac CT examinations, and a small but significant percentage of women may instead have had potentially life-saving interventions with cardiac procedures.

The study had several limitations, including lack of a control group and lack of actual CV outcome data. Although investigators did not report the number of women who changed their medication regimens or modified their lifestyle based on awareness of BAC, 34 of the 42 women responding to the survey affirmed the belief that it was beneficial to know about BAC after mammography. Thirty-nine of the 42 survey respondents (92.8%) underwent a baseline health assessment, and none of these patients reported a known history of CAD. Although this publication did not report the health status of the minority of patients with BAC who did not complete the follow-up survey (26/68, 38.2%), it is possible that some of these women already had known CVD, and further investigation was therefore not performed. Despite study limitations, many survey respondents valued the information about BAC and pursued additional medical assessments for their CV health. More data are needed to understand whether and to what extent BAC reporting would reduce morbidity and/or mortality from CVD.

Given that women between the ages of 35 and 54 years presenting with acute MI are less likely than men to receive treatment supported by guidelines (ie, medication for lipid lowering, antiplatelet therapy other than aspirin,

and beta blockers as well as coronary angiography and revascularization),[84] we suggest that mammography could represent an opportunity to provide an additional risk factor assessment of potential CVD. In this way, breast imaging radiologists might support a more comprehensive approach to women's health.

Methods of assessment for BAC

There is presently no standardized assessment method for BACs. Current methods utilized for reporting BAC include stating the presence or absence of BAC vs various systems of grading BAC severity in which a 3-point, 4-point, or 12-point scale is assigned based on various visual criteria as subjectively determined by a radiologist.[55] A recent meta-analysis showed that the association of BAC and CAD was still significant when stratified by method of BAC reporting by presence or absence of BAC (odds ratio [OR], 2.05; 95% CI, 1.70-2.47) vs grading BAC (OR, 4.04; 95% CI, 2.59-6.30).[55] The same authors performed a subanalysis of studies using either a 4- or 12-point grading system for BAC and demonstrated associations of moderate to severe BAC and CAD but not with mild BAC and CAD. This suggests that the degree of BAC, and therefore the grading of BAC, may provide useful insights into the predictive value of BAC for CAD.

Although Lee et al[55] concluded that a consensus on a method of BAC reporting would be helpful for future studies, a recent literature review summarizing >60 articles about BAC and CAD/CVD from 1980 to 2022[12] illustrates variable assessment of BAC across studies. Some studies only reported the presence or absence of BAC or applied a grading system, while others declared the presence or absence of BAC and graded BAC severity.

Artificial intelligence has also been applied to detect[11,85] and quantify[11,86] BAC. The recent retrospective study by Allen et al utilizing the proprietary software cmAngio by CureMetrix, with an ROC of 0.98 (94% sensitivity and 96% specificity) when compared with human readers, has successfully measured BAC and demonstrates that AI can be applied to measure BAC either as a binary or continuous measure.[11] Given the current demands on radiologists interpreting screening mammography in many practice settings, manually applying a multipoint grading system for BACs may create workflow disruptions. Therefore, using AI for identification and quantification of BAC might improve efficiency and reduce workflow demands. More specific AI detection methods will be discussed in the next section.

Breast arterial calcifications and AI

Breast arterial calcification detection and quantification

For detection of BACs on mammography, Mobini et al trained a deep convolutional neural network (CNN) to detect and quantify BAC.[87] On 4 standard mammographic screening views (performed on a combination of full-field digital units and units with tomosynthesis), 3 readers identified the patient as positive or negative for BAC, and a fourth reader applied labels to each mammogram image as BAC positive and negative. Lengths of calcified vessel segments had already been labeled from prior research. Patients aged <45 years were excluded from the analysis. Similar to previously cited literature, these authors found that 13% of 1493 women had BAC on mammography. The prevalence of BAC increased with age; mean age for patients with BAC was 70.5 years, and mean age for patients without BAC was 57 years. When compared with ground truth for the presence or absence of BAC, the AI CNN had an area under the curve (AUC)–ROC of 0.94. Preliminary quantification analysis of BAC area in a small number of mammograms was strongly correlated with manual measurements (rho = 0.88, $P < .001$). Subsequent comparative retrospective analyses of 11 pretrained CNNs were also performed with deep transfer learning, and 3 of the CNNs had AUC-ROC >0.70.[88]

Breast arterial calcification segmentation and quantification

To address the challenges of segmentation of curvilinear structures using AI, a recurrent attention U-Net model (RAU-Net) was applied to ~2000 synthesized 2D images from digital breast tomosynthesis examinations for BAC segmentation and quantification.[89] Radiologists established ground truth by performing manual segmentation of BAC on craniocaudal and mediolateral oblique synthetic views on a total of 1436 images. Severity of BAC was graded on a scale of 0 to 3 (0 = none, 1 = few, 2 = moderate, 3 = severe—3 or more vessels). For segmentation, the model demonstrated an overall accuracy of 99.9%, sensitivity of 69.6%, precision of 68.4%, and Jaccard index of 59.5%. When comparing related models and RAU-Net with ground truth for segmentation, RAU-Net demonstrated the highest AUC of 0.96. For quantification of BAC, ground truth (radiologist performance) and quantification metrics of the tested model showed positive correlations between 0.71 and 0.83.

Breast arterial calcification predicting risk of CAC

Ahn et al developed a CNN to predict CAC on CT based on BAC.[90] The study evaluated model performance for 6443 women with standard 4-view digital screening mammograms and CT of the coronary arteries that was performed at the time of routine health screening examinations. Data regarding conventional CV risk factors and menopausal status were also collected. Primary study endpoint was the prevalence of any CAC with secondary endpoint of prevalence of CAC score >10 or >100. When incorporating age and status of menopause with BAC on mammography to predict CAC, the evaluated deep learning system demonstrated a similar diagnostic performance to the Framingham Risk Score (AUC-ROC, 0.776; 95% CI, 0.762-0.790; and AUC-ROC, 0.736; 95% CI, 0.712-0.761), respectively.

Current barriers to reporting BAC, knowledge gaps, and future directions

Presently, there are no standardized methods for measuring, reporting, or managing the reported findings of BAC on screening mammography. Professional society guidelines do not yet exist in radiology to guide reporting of BAC. Although AI can be implemented to facilitate the assessment and measurement of BAC to reduce radiologist workload, more research is needed to validate various assessment methods and reliably correlate assessment methods with CV outcome data. More prospective research is needed to evaluate the relationship of BAC and CV outcomes to determine which population of women receiving mammograms would most benefit from consultation with cardiology or another medical professional for an assessment of CV health. Ongoing multidisciplinary collaborations between radiology and cardiology would likely be needed to facilitate appropriate referral patterns for women with BAC. Although some cardiologists may recognize the potential utility of BAC as an additional independent risk factor for CVD, clinical outcome data would also be helpful regarding clinical management algorithms for patients without clinical signs or symptoms of CVD who demonstrate BAC on mammography.

It is also unclear whether BAC reporting would significantly change the frequency of diagnostic testing for CAD, such as cardiac CT and angiography. Additional research may be needed to assess how BAC reporting might impact the rates of utilization for pharmacologic and interventional therapies offered to patients. Cost-effectiveness analyses might also be useful.

Other considerations for reporting BAC on mammography include timely education for patients and physicians who read and receive mammography results. Additional studies evaluating patient perspectives on BAC reporting in the setting of an indeterminate screening mammogram would be helpful to optimize communication strategies. Physicians ordering screening mammography would also require education about BAC reporting as well as any applicable referral pathways.

Conclusion

The correlation between increasing age and greater risk of developing heart disease or cancer is well established, and mammography might represent an opportunity to identify and possibly mitigate CV risk factors at an earlier age. More data are needed to elucidate the clinical impact of reporting BAC in mammography reports and address the utility of various methods of BAC measurement. Artificial intelligence might not only facilitate the identification and automated quantification of BAC but also the creation of CV risk models that incorporate BAC on mammography. In the short term, BAC reporting may represent a next step to support future data collection for prospective, longitudinal studies to further elucidate the predictive value of BAC for asymptomatic CAD/CVD. Ultimately, reporting BAC might lead to the identification of opportunities to mitigate CV risk factors in women with subclinical CVD.

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Conflicts of interest statement

J.R., L.C., and L.A.V. have no disclosures. M.S.N. is the Associate Executive Director for Diagnostic Radiology for the American Board of Radiology, a member of the board of directors for the Society of Breast Imaging, for The Academy for Radiology and Biomedical Research, and for the American Board of Medical Specialties, and an advisor for National Mammography Quality Assurance Committee, Food and Drug Administration. G.H.M. has been a consultant for iCAD. S.V.D. is the Chair of the American College of Radiology (ACR) Breast Imaging Commission and has advised Hologic and iCAD. L.M. has been a consultant for iCAD, participated on the ACR Data Safety Monitoring Board, and is the President of the Society of Breast Imaging. R.F.B. serves on the Board of Directors for Screenpoint Medical. C.P. is Chief Medical Officer for Solis Mammography. L.R.M. is a consultant for Screenpoint Medical and a member of the board of directors for the Society of Breast Imaging. These relationships are not directly relevant to the submitted work.

Author contributions

Joanna Rossi (Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Software, Writing - original draft, Writing - review & editing), Leslie Cho (Conceptualization, Formal analysis, Methodology, Supervision, Writing - original draft, Writing - review & editing), Mary S. Newell (Conceptualization, Formal analysis, Methodology, Supervision, Writing - review & editing), Luz A. Venta (Conceptualization, Formal analysis, Methodology, Writing - review & editing), Guy H. Montgomery (Conceptualization, Formal analysis, Methodology, Writing - review & editing), Stamatia V. Destounis (Conceptualization, Methodology, Writing - review & editing), Linda Moy (Conceptualization, Methodology, Writing - review & editing), Rachel F. Brem (Methodology, Writing - review & editing), Chirag Parghi (Conceptualization, Methodology, Writing - review & editing), and Laurie R. Margolies (Conceptualization, Formal analysis, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing)

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