

CÁNCER DE MAMA: UN ENFOQUE INTEGRAL DESDE LOS FACTORES DE RIESGO HASTA EL TRATAMIENTO PERSONALIZADOYalda Azimzadeh-Moghaddam¹E-mail: azimzadehyalda@gmail.comORCID: <https://orcid.org/0009-0001-0177-4564>¹ University of Georgia. Georgia.**Suggested Citation (APA, 7th edition)**Azimzadeh-Moghaddam, Y. (2026). Breast cancer: a comprehensive approach from risk factors to personalized treatment. *Revista UGC*, 4(4), 47-56.**Submission:** 06/20/2026**Acceptance:** 08/28/2026**Publication:** 10/01/2026**ABSTRACT**

Breast cancer represents one of the leading global health challenges due to its high incidence, mortality, and considerable biological and clinical heterogeneity. Its development is associated with the interaction of genetic, hormonal, reproductive, environmental, and behavioral factors, requiring an integrated approach encompassing prevention, early detection, accurate diagnosis, and individualized treatment. The objective of this article was to analyze the main risk factors associated with breast cancer, examine current approaches to prevention and early detection, and describe diagnostic and therapeutic strategies, with particular emphasis on the transition toward personalized treatment. Methodologically, an integrative narrative review of the scientific literature was conducted, including original articles, systematic reviews, evidence syntheses, epidemiological studies, clinical practice guidelines, and institutional documents. The information was organized through thematic analysis covering epidemiology, susceptibility, risk factors, prevention, screening, diagnosis, molecular characterization, and treatment. The findings indicate that susceptibility to breast cancer results from multiple modifiable and non-modifiable determinants and varies considerably among individuals and populations. Early detection expands therapeutic opportunities, although its effectiveness depends on continuity between screening, diagnostic confirmation, and access to appropriate treatment. Furthermore, advances in genomics, biomarkers, and molecular characterization have revealed the biological diversity of breast tumors and increasingly support more precise therapeutic decisions. Overall, the evidence supports an integrated model combining individualized risk assessment, prevention, surveillance, early diagnosis, tumor characterization, and personalized

treatment to improve clinical outcomes and reduce the global burden of breast cancer.

Keywords:

Breast cancer, risk factors, early detection, diagnosis, personalized treatment.

RESUMEN

El cáncer de mama constituye uno de los principales problemas de salud a escala mundial debido a su elevada incidencia, mortalidad y marcada heterogeneidad biológica y clínica. Su desarrollo está relacionado con la interacción de factores genéticos, hormonales, reproductivos, ambientales y conductuales, lo que exige integrar prevención, detección temprana, diagnóstico preciso y tratamiento individualizado. El objetivo de este artículo fue analizar los principales factores de riesgo asociados con el cáncer de mama, examinar los enfoques actuales de prevención y detección temprana y describir las estrategias diagnósticas y terapéuticas, con énfasis en la transición hacia el tratamiento personalizado. Metodológicamente, se realizó una revisión narrativa integradora de la literatura científica, que incluyó artículos originales, revisiones sistemáticas, síntesis de evidencia, estudios epidemiológicos, guías de práctica clínica y documentos institucionales. La información fue organizada mediante análisis temático, considerando epidemiología, susceptibilidad, factores de riesgo, prevención, cribado, diagnóstico, caracterización molecular y tratamiento. Los hallazgos muestran que la susceptibilidad al cáncer de mama resulta de múltiples determinantes modificables y no modificables y varía entre individuos y poblaciones. La detección temprana mejora las oportunidades terapéuticas, aunque su efectividad depende de la continuidad entre cribado, confirmación diagnóstica y acceso al tratamiento. Asimismo,



los avances en genómica, biomarcadores y caracterización molecular han demostrado la diversidad biológica de los tumores y favorecido decisiones terapéuticas más precisas. En conjunto, la evidencia respalda un modelo integrado que articula evaluación individual del riesgo, prevención, vigilancia, diagnóstico temprano, caracterización tumoral y tratamiento personalizado para mejorar los resultados clínicos y reducir la carga del cáncer de mama.

Palabras clave:

Cáncer de mama, factores de riesgo, detección temprana, diagnóstico, tratamiento personalizado.

INTRODUCTION

Breast cancer remains one of the most significant challenges in global health because of its high incidence, biological heterogeneity, and profound impact on morbidity and mortality. It is the most commonly diagnosed cancer among women in many regions of the world and can also occur in men, although much less frequently. Despite substantial advances in prevention, diagnostic technologies, molecular characterization, and therapeutic approaches, the burden of the disease continues to affect millions of individuals, families, and health systems. According to the World Health Organization (2025), approximately 2.3 million women were diagnosed with breast cancer worldwide in 2022, while about 670,000 deaths were attributed to the disease. These figures highlight the need to approach breast cancer not only from the perspective of treatment after diagnosis but also through comprehensive strategies encompassing risk assessment, prevention, early detection, and individualized clinical management.

Breast cancer is a complex and multifactorial disease whose development results from interactions among genetic, hormonal, reproductive, environmental, and lifestyle-related factors. Age, sex, family history, inherited genetic susceptibility, reproductive history, and breast density are among the factors that can influence individual risk. At the same time, potentially modifiable determinants, including alcohol consumption, obesity, physical inactivity, and certain patterns of hormonal exposure, have received increasing attention because they provide opportunities for prevention and risk reduction. Nevertheless, the relative contribution of individual risk factors varies considerably, and the presence of one or several factors does not necessarily predict the development of the disease. Contemporary evidence therefore emphasizes the importance of understanding breast cancer risk through an integrated and individualized perspective rather than through isolated determinants (Løyland et al., 2024; Sun et al., 2017; Winkler & Hetjens, 2024).

The biological complexity of breast cancer further reinforces the need for this comprehensive approach. Breast cancer does not represent a single pathological entity but encompasses a heterogeneous group of malignancies

characterized by differences in histological features, molecular profiles, clinical behavior, prognosis, and therapeutic response. Advances in molecular biology and genomic research have contributed to a more precise understanding of this heterogeneity and have progressively transformed traditional approaches to classification and clinical decision-making. Consequently, the identification of prognostic and predictive biomarkers has become increasingly important for determining disease characteristics, estimating outcomes, and selecting appropriate therapeutic strategies (Łukasiewicz et al., 2021).

Within this context, early detection constitutes a fundamental component of breast cancer control. The prognosis of patients is closely associated with the stage at which the disease is identified, making timely diagnosis essential for improving therapeutic possibilities and clinical outcomes. Screening strategies and diagnostic procedures are therefore central to detecting breast abnormalities before disease progression compromises treatment options. Mammography remains a major screening method, while clinical assessment and complementary imaging and diagnostic techniques contribute to the evaluation of suspicious findings. However, the effectiveness of early detection depends not only on technological availability but also on population awareness, accessibility of health services, appropriate risk assessment, and timely diagnostic confirmation (Hoque et al., 2024).

The relationship between prevention and early diagnosis is particularly important because both strategies seek to reduce the consequences of disease before advanced stages are reached. Primary prevention focuses on reducing exposure to modifiable risk factors and promoting protective behaviors, whereas secondary prevention is directed toward detecting disease at an earlier and potentially more treatable stage. Evidence concerning breast cancer prevention increasingly supports the promotion of healthy lifestyles, including regular physical activity, maintenance of an appropriate body weight, and reduction of alcohol consumption, alongside individualized preventive strategies for persons at increased risk (Sun et al., 2017; Winkler & Hetjens, 2024).

At the same time, progress in breast cancer treatment has shifted clinical practice toward increasingly personalized therapeutic decision-making. Surgery, radiotherapy, chemotherapy, endocrine therapy, and targeted treatments continue to constitute major components of management, but their selection and combination increasingly depend on tumor characteristics, disease stage, receptor status, molecular features, patient-related factors, and expected therapeutic benefit. This transition from predominantly standardized treatment schemes toward more individualized approaches reflects the growing recognition that optimal breast cancer care requires adapting therapeutic interventions to the biological and clinical characteristics of each patient (Hoque et al., 2024; Łukasiewicz et al., 2021).

Thus, contemporary breast cancer management can be understood as a continuum extending from the identification and modification of risk factors to early detection, accurate diagnosis, biological characterization, treatment selection, and follow-up. Examining these components together is essential because advances in one area directly influence decisions in others. Risk stratification can guide preventive and screening strategies; early detection can expand therapeutic options; and increasingly detailed tumor characterization can support more precise treatment selection. Integrating these dimensions provides a more coherent understanding of current approaches to reducing breast cancer incidence, improving timely diagnosis, and optimizing clinical outcomes.

Accordingly, the objective of this article is to analyze the principal risk factors associated with breast cancer, examine current approaches to prevention and early detection, and describe the main diagnostic and therapeutic strategies, with particular emphasis on the transition toward personalized treatment based on individual risk and the biological and clinical characteristics of the disease.

MATERIALS AND METHODS

This study was conducted as an integrative narrative review of the scientific literature focused on the continuum of breast cancer care, from the identification of risk factors and early detection to diagnosis and personalized treatment. The methodological approach was designed to provide a broad and critical synthesis of current knowledge rather than to quantify the effect of a single intervention or clinical outcome. Particular attention was given to evidence capable of connecting epidemiological and biological susceptibility with prevention, screening, diagnostic assessment, molecular characterization, and contemporary therapeutic decision-making.

The literature included scientific articles, systematic reviews, evidence syntheses, clinical practice guidelines, epidemiological studies, original research, and relevant institutional documents addressing breast cancer. Priority was given to peer-reviewed publications and authoritative sources with direct relevance to the objectives of the review. The documentary corpus included publications addressing epidemiology and risk factors, hereditary and early-onset breast cancer, modifiable and non-modifiable determinants, prevention, screening, diagnostic procedures, tumor biology, molecular mechanisms, prognostic and predictive markers, conventional and emerging treatments, and personalized therapeutic approaches. The sources ultimately incorporated into the analysis span different types of evidence and include recent publications together with earlier works retained because of their relevance to specific aspects of the subject.

The selection of the literature was guided by thematic relevance, scientific contribution, relationship with the objective of the article, and capacity to provide

complementary perspectives on the breast cancer care pathway. Publications were considered when they contributed information on at least one of the central analytical domains: epidemiology and susceptibility; genetic, reproductive, hormonal, environmental, or lifestyle-related risk factors; prevention and risk reduction; screening and early detection; diagnostic and molecular characterization; or therapeutic management and personalization. Sources whose content did not contribute directly to these domains or whose focus was unrelated to the purpose of the review were not considered in the final synthesis.

No restriction to a single study design was established because the objective required integration of heterogeneous forms of evidence. This decision made it possible to combine population-level epidemiological findings with systematic evidence syntheses, clinical recommendations, molecular research, studies of specific populations, and analyses of emerging therapeutic technologies. Particular consideration was given to populations whose characteristics may require differentiated approaches, including younger women, individuals with hereditary susceptibility, women with benign breast disease, and men with breast cancer. These groups are explicitly represented in the evidence analyzed in the article.

The information obtained from the selected publications was organized through thematic content analysis. In the first stage, the principal findings of each source were identified according to their contribution to understanding breast cancer risk, prevention, detection, diagnosis, biological characterization, or treatment. In the second stage, findings addressing similar dimensions were compared to identify areas of convergence, complementarity, and clinically relevant differences. In the third stage, the evidence was integrated into a sequential analytical framework that follows the progression from susceptibility and risk assessment to prevention, early detection, diagnostic confirmation, tumor characterization, therapeutic selection, and individualized management.

The synthesis did not consist solely of describing individual publications. Instead, evidence was critically integrated to determine how advances in different areas contribute to a more comprehensive model of breast cancer control. Particular emphasis was placed on the distinction between modifiable and non-modifiable risk factors, the interaction between genetic susceptibility and lifestyle, the importance of risk-adapted surveillance, the relationship between early detection and diagnostic continuity, the biological heterogeneity of breast tumors, and the increasing use of clinical and molecular characteristics to guide therapeutic decisions. These analytical dimensions correspond to the principal patterns identified throughout the reviewed literature.

Finally, the interpretation of the evidence was structured from an integrative clinical and public health perspective. Rather than considering prevention, diagnosis, and

treatment as isolated components, the analysis examined their interdependence across the breast cancer care pathway. This methodological orientation allowed the review to assess how knowledge of susceptibility can inform prevention and surveillance, how timely detection can influence diagnostic and therapeutic opportunities, and how increasingly precise biological characterization can support personalized treatment.

RESULTS AND DISCUSSION

Breast cancer represents a major challenge for contemporary medicine and public health because its impact extends far beyond the occurrence of a malignant tumor. The disease affects survival, quality of life, family dynamics, healthcare expenditure, and the physical and psychological well-being of those diagnosed. Its importance is also related to the fact that reducing its burden requires action at different moments, from prevention and recognition of susceptibility to timely diagnosis and access to effective treatment. Scientific progress has considerably expanded the possibilities for understanding and managing the disease; however, important challenges remain in translating this knowledge into earlier detection, more precise clinical decisions, and better outcomes across different populations. The continuing global burden of breast cancer therefore makes it essential to examine the problem as a major health priority in which epidemiological, biological, preventive, diagnostic, and therapeutic dimensions converge (World Health Organization, 2025).

The analysis of the selected literature revealed several major findings that help explain the current direction of breast cancer research and clinical management. First, susceptibility to the disease is determined by the interaction of multiple factors rather than by a single cause. Second, distinguishing modifiable from non-modifiable determinants provides an essential basis for prevention and individualized risk assessment. Third, timely detection remains closely associated with opportunities for more effective clinical intervention. Finally, advances in tumor characterization have progressively strengthened the transition toward treatment decisions based on the particular biological and clinical profile of each patient. Together, these findings indicate that breast cancer control requires coordinated action across risk assessment, prevention, detection, diagnosis, and therapy rather than independent interventions at each stage (Hoque et al., 2024; Łukasiewicz et al., 2021; Winkler & Hetjens, 2024).

A particularly consistent finding across the reviewed studies is the multifactorial character of breast cancer susceptibility. The evidence identifies a combination of demographic, genetic, reproductive, hormonal, environmental, and behavioral determinants whose influence may vary substantially among individuals. Age and female sex represent fundamental determinants, while family history and inherited genetic susceptibility acquire particular

relevance in specific groups. Reproductive characteristics and cumulative hormonal exposure also contribute to variations in risk. This diversity demonstrates why the probability of developing breast cancer cannot be estimated adequately from one factor considered in isolation and supports the use of increasingly comprehensive risk-assessment approaches (Løyland et al., 2024; Sun et al., 2017; Winkler & Hetjens, 2024).

The distinction between modifiable and non-modifiable factors is especially relevant from a preventive perspective. Biological aging, inherited susceptibility, family history, and certain reproductive characteristics cannot be modified, but their recognition can identify individuals who may benefit from closer surveillance and more specific preventive strategies. In contrast, alcohol consumption, excess body weight, insufficient physical activity, and other lifestyle-related exposures provide potential areas for intervention. Nevertheless, the available evidence does not support interpreting prevention as the complete elimination of breast cancer risk. Risk reduction should instead be understood as a probabilistic process in which healthier behaviors may decrease exposure to certain determinants without eliminating the influence of genetics, aging, hormonal history, or other biological mechanisms (Løyland et al., 2024; Sun et al., 2017; Winkler & Hetjens, 2024).

This distinction has an additional implication for health communication. Preventive recommendations should avoid creating the impression that the occurrence of breast cancer is necessarily the consequence of individual behavior. Some patients develop the disease despite having no clearly identifiable major modifiable risk factors, whereas other individuals with several recognized factors never develop it. The value of risk-factor knowledge therefore lies in supporting informed decisions, identifying higher-risk populations, guiding preventive interventions, and determining when intensified surveillance may be appropriate. In this sense, prevention becomes more effective when behavioral recommendations are combined with individualized assessment and organized healthcare strategies.

Another central finding concerns the role of early detection in modifying the clinical trajectory of the disease. Identifying suspicious lesions before extensive progression can increase therapeutic possibilities and facilitate interventions at stages in which disease management may be less complex. Mammography remains a fundamental screening resource, but the reviewed evidence shows that breast assessment cannot be reduced to a single diagnostic technique. Clinical evaluation, imaging methods, pathological examination, and additional tests must be integrated according to the characteristics of the patient and the findings obtained during the diagnostic process (Hoque et al., 2024; Łukasiewicz et al., 2021).

The benefits associated with early detection also depend on factors beyond technological capacity. Screening has limited value if abnormal findings are not followed by timely diagnostic confirmation and appropriate treatment. Awareness, accessibility, continuity of care, availability of specialized professionals, diagnostic infrastructure, and coordination among health services can determine whether an early abnormality ultimately translates into an earlier cancer diagnosis. This observation is particularly important when breast cancer is considered from a public health perspective because inequalities in access may influence the stage at which patients enter the healthcare system.

The literature also demonstrates that diagnostic assessment has evolved substantially as knowledge of breast tumor biology has expanded. Histopathological examination remains indispensable, but diagnosis increasingly provides information that goes beyond confirming malignancy. Tumor characteristics, receptor expression, prognostic markers, and molecular information can contribute to determining biological behavior and anticipated therapeutic response. This represents a major change in clinical reasoning: diagnosis is no longer limited to determining whether breast cancer is present but increasingly contributes to defining what type of disease is present and how it should be managed (Łukasiewicz et al., 2021).

Such progress is particularly significant because breast cancer encompasses tumors with considerable biological and clinical diversity. Differences in molecular characteristics can influence aggressiveness, patterns of progression, prognosis, and sensitivity to specific therapies. Consequently, patients with apparently similar anatomical disease may require different therapeutic strategies. Recognition of this heterogeneity has provided one of the principal scientific foundations for personalized treatment and has strengthened the relationship between diagnostic precision and therapeutic selection.

Treatment has consequently evolved toward greater individualization. Surgery and radiotherapy continue to play essential roles in local disease management, whereas systemic approaches may involve chemotherapy, endocrine therapy, targeted treatments, or combinations of different modalities. The appropriate strategy depends on factors such as disease extent, tumor characteristics, receptor status, expected response, potential toxicity, and patient-related conditions. Contemporary management therefore seeks not simply to administer the greatest possible therapeutic intensity but to select interventions capable of producing the greatest expected benefit while limiting unnecessary toxicity (Hoque et al., 2024; Łukasiewicz et al., 2021).

This transition has important implications for the concept of personalized treatment. Personalization should not be understood exclusively as the use of advanced or novel therapies. It involves integrating information obtained

throughout the clinical process to determine which interventions are most appropriate for a specific patient. Risk profile, diagnostic findings, pathological characteristics, biological markers, disease stage, general health status, and individual circumstances may all contribute to therapeutic decision-making. Personalized care therefore represents a broader transformation in the way breast cancer is evaluated and treated.

The reviewed evidence ultimately shows that the greatest potential for improving breast cancer outcomes lies in connecting the different components of care. Knowledge of risk can guide prevention and surveillance; appropriate surveillance can facilitate timely identification; precise diagnosis can reveal clinically relevant tumor characteristics; and these characteristics can guide therapeutic selection. Fragmentation between these components may reduce their effectiveness, whereas their integration can strengthen the entire clinical pathway.

From this perspective, the principal challenge for the coming years is not only to generate new scientific knowledge but also to ensure that advances in prevention, risk assessment, detection, diagnosis, and treatment operate as interconnected elements of breast cancer control. The evidence examined supports a model in which population-level prevention and individualized medicine are complementary rather than competing approaches. Combining both perspectives offers greater possibilities for reducing preventable risk, identifying disease at clinically favorable stages, improving therapeutic precision, and ultimately decreasing the human and healthcare burden associated with breast cancer.

In this context, particular attention should be given to early-onset and hereditary breast cancer, since these forms of the disease raise specific challenges for risk assessment and surveillance. Cortiana et al. (2025) emphasize that advances in risk stratification and imaging are improving the identification and clinical management of individuals with inherited susceptibility or an increased probability of developing breast cancer at younger ages. Their analysis supports the integration of genetic information, family history, and imaging approaches to achieve more individualized surveillance, particularly among populations whose risk profile differs from that of women undergoing conventional age-based screening.

Closely related to this issue, breast cancer in young women requires approaches that consider the distinctive clinical and preventive needs of this population. Sharma & Saripilli (2025) examine recent developments in diagnosis, screening, prevention, and treatment, highlighting the importance of recognizing that strategies designed for the general population may not always adequately address younger women. Their contribution reinforces the need for risk-adapted assessment and greater attention to early-onset disease, particularly when hereditary

predisposition, family history, or other relevant factors suggest the need for intensified surveillance.

Beyond age and hereditary predisposition, understanding breast cancer also requires consideration of the molecular mechanisms involved in tumor initiation and progression. Feng et al. (2018) provide a comprehensive analysis connecting established risk factors with cancer stem cells, signaling pathways, genomic alterations, and molecular pathogenesis. This perspective is particularly valuable because it demonstrates that epidemiological susceptibility and tumor biology are interconnected dimensions of the same disease process. Knowledge of these mechanisms has contributed to a more detailed classification of breast tumors and provides a scientific basis for the identification of biomarkers and molecular targets with potential diagnostic, prognostic, and therapeutic relevance.

From a broader epidemiological perspective, the distribution of breast cancer risk is not uniform across populations. Roheel et al. (2023), through a systematic review of global epidemiology based on risk factors, demonstrate the relevance of considering demographic, reproductive, genetic, environmental, and lifestyle-related determinants when interpreting differences in breast cancer occurrence. Their findings support the need to adapt preventive strategies to population characteristics rather than assuming that the same combination of risk factors has an identical impact in every geographical and socioeconomic context.

Once the disease has been detected, however, the central challenge shifts from risk identification to accurate characterization and evidence-based clinical management. The European Society for Medical Oncology guideline developed by Loibl et al. (2024) illustrates the increasingly multidisciplinary nature of early breast cancer care, integrating diagnosis, pathological and molecular assessment, local and systemic treatment, and follow-up. Of particular significance is the growing use of tumor-specific characteristics to guide therapeutic decisions, which reflects the transition from broadly uniform treatment approaches toward strategies increasingly adapted to disease biology and individual clinical circumstances.

In parallel, the relationship between risk recognition and diagnostic accuracy remains fundamental to improving clinical outcomes. Obeagu & Obeagu (2024) review the principal factors associated with breast cancer development together with the diagnostic approaches used to identify the disease. Their work underscores the value of connecting knowledge of susceptibility with diagnostic evaluation, since recognizing relevant risk profiles can contribute to greater clinical vigilance and more appropriate investigation of suspicious findings. This connection is particularly important when symptoms are subtle or when individuals have characteristics associated with increased susceptibility.

Building on this risk-oriented perspective, García-Sancha et al. (2025) approach breast cancer susceptibility as the result of interactions among genetic, hormonal, environmental, and lifestyle-related components. Their analysis is especially relevant to prevention because it moves beyond the identification of isolated determinants and considers how knowledge of susceptibility can be translated into preventive strategies. Such an approach strengthens the concept of risk-adapted prevention, in which recommendations and surveillance may be adjusted according to individual characteristics rather than applied uniformly to all individuals.

Nevertheless, not all determinants can be modified through preventive interventions. The American Cancer Society (2026) identifies several non-modifiable factors associated with breast cancer risk, including increasing age, inherited genetic changes, family history, personal history of breast cancer or certain breast conditions, reproductive characteristics, and other biological circumstances. Recognition of these factors is clinically valuable even when they cannot be changed because they can contribute to identifying individuals who may require more intensive assessment or surveillance. Thus, the practical significance of a risk factor does not depend exclusively on whether it can be eliminated, but also on whether it improves the identification of individuals requiring differentiated care.

Precisely because risk identification must lead to appropriate clinical action, the quality of diagnostic processes deserves particular consideration. Zehra et al. (2023) emphasize that early diagnosis should be accompanied by rigorous evaluation of the full range of relevant risk factors and by appropriate interpretation of genetic findings. They also draw attention to limitations associated with insufficient knowledge of screening practices, social barriers to discussing breast health, and restricted access to screening resources. Their observations demonstrate that early diagnosis is not simply a question of detecting disease sooner; it also requires scientifically sound assessment, adequate health literacy, and healthcare conditions that permit suspicious findings to be investigated without unnecessary delay.

The discussion of risk can be further strengthened by evidence derived from genetic epidemiology. Escala-Garcia et al. (2020), using a Mendelian randomisation approach, examined breast cancer risk factors and their potential effects on survival. Their study is important because it attempts to move beyond conventional observational associations by using genetic information to investigate possible causal relationships. This type of evidence contributes to a more critical interpretation of risk factors, helping to differentiate variables that merely correlate with breast cancer from those that may have a more direct role in disease development or prognosis.

A particularly relevant population for risk stratification consists of women with benign breast disease. Burke et al. (2025) systematically reviewed determinants of subsequent breast cancer risk among these women and highlighted the importance of considering characteristics beyond the mere presence of a benign lesion. Their findings suggest that risk assessment in this population can benefit from combining information related to benign breast disease with other established determinants. This supports a more refined approach to surveillance in which women with benign findings are not treated as a homogeneous group but are evaluated according to their broader risk profile.

The importance of what occurs before definitive diagnosis is further illustrated by Kūçūkerdem et al. (2026), who examined the association of pre-diagnosis breast assessment practices and risk factors with breast cancer stage at diagnosis. Their findings bring attention to the period preceding diagnostic confirmation and reinforce the relevance of appropriate breast assessment in determining how and when the disease is ultimately identified. This perspective is especially useful because stage at diagnosis can substantially influence subsequent management, making the pathway from initial assessment to diagnostic confirmation a critical component of breast cancer control.

Although breast cancer research and prevention predominantly focus on women, the disease also occurs in men and should not be excluded from a comprehensive analysis. Giordano et al. (2002) highlighted the particular characteristics of male breast cancer and the challenges associated with its relatively low frequency. The rarity of the disease in men can contribute to limited awareness and delayed recognition, while clinical management has historically relied substantially on knowledge derived from female breast cancer. Including male breast cancer in the discussion therefore emphasizes that sex strongly influences incidence but does not make the disease exclusive to women.

Alongside improvements in detection and patient stratification, therapeutic research continues to explore new mechanisms for delivering anticancer agents more selectively and effectively. Sartaj et al. (2021) discuss the potential of polymeric nanoparticles as drug-delivery systems in breast cancer therapy, emphasizing their capacity to improve the delivery of therapeutic compounds and contribute to targeted treatment approaches. Although such technologies require continued evaluation and translation into clinical practice, nanotechnology illustrates how personalization may increasingly involve not only the selection of a drug but also the optimization of how therapeutic agents reach tumor tissues.

Furthermore, the relationship between inherited susceptibility and lifestyle provides an important opportunity to understand how different dimensions of risk may interact. Zhang et al. (2025) investigated genetic risk together

with health-associated lifestyle in relation to early-onset cancer and breast cancer. Their work is particularly relevant because genetic predisposition should not necessarily be interpreted independently of behavioral factors. Considering these dimensions jointly may improve risk stratification and supports the broader principle that inherited susceptibility and potentially modifiable exposures can coexist within the same individual risk profile.

Finally, these specific findings can be placed within the wider epidemiological framework described by Zafar et al. (2022), who review the epidemiology and major risk factors associated with breast cancer. Their contribution helps connect individual-level susceptibility with the population distribution of the disease and underscores the importance of epidemiological evidence for identifying groups in which preventive and diagnostic interventions may have the greatest impact. Viewed together with the preceding studies, this perspective reinforces the progression from population-level knowledge of breast cancer risk toward increasingly individualized prevention, surveillance, diagnosis, and treatment.

Taken together, the contributions analyzed provide a comprehensive understanding of breast cancer as a heterogeneous disease whose prevention and management require the integration of epidemiological, genetic, biological, diagnostic, and therapeutic knowledge. The evidence shows that susceptibility varies considerably among individuals and populations and that its assessment is becoming increasingly precise through the combined consideration of hereditary background, personal characteristics, environmental exposures, lifestyle, reproductive history, and specific clinical conditions. This broader perspective is especially important for groups requiring differentiated attention, including young women, individuals with hereditary predisposition, women with benign breast disease, and men.

Another major contribution is the consolidation of a risk-based approach to prevention and surveillance. Current knowledge makes it possible to identify populations that may benefit from intensified monitoring while simultaneously recognizing opportunities for intervention on preventable exposures. Genetic epidemiology and advances in molecular research are also helping to clarify the biological pathways involved in susceptibility and disease progression, thereby improving the distinction between simple statistical associations and factors with greater potential biological or causal relevance. This development strengthens the scientific basis for more accurate prediction models and differentiated preventive strategies.

The findings also highlight that successful breast cancer control depends on the quality and continuity of the entire diagnostic pathway. Screening alone cannot guarantee favorable outcomes if suspicious findings are not adequately evaluated or if barriers delay diagnostic confirmation. Clinical assessment, imaging, pathology, molecular

characterization, health literacy, accessibility of services, and appropriate follow-up must operate in a coordinated manner. Particular attention should therefore be paid to the period preceding definitive diagnosis, as the effectiveness of assessment practices during this stage may influence when the disease is identified and consequently the therapeutic options available.

At the biological level, advances in genomics, signaling pathways, cancer stem cell research, biomarkers, and molecular characterization have transformed the understanding of breast cancer from that of a relatively uniform malignancy into a group of diseases with distinct behaviors and therapeutic vulnerabilities. This knowledge provides the foundation for increasingly precise clinical classification and helps explain differences in progression, prognosis, and treatment response. Consequently, therapeutic decision-making is progressively shifting toward strategies that reflect the particular characteristics of the tumor and the patient rather than relying exclusively on conventional clinical parameters.

Therapeutic innovation further expands this individualized perspective. In addition to established local and systemic approaches, emerging technologies such as advanced drug-delivery systems illustrate the potential to improve how anticancer agents are directed toward tumor tissues. Personalized treatment can therefore encompass not only the selection of the most appropriate therapeutic agent but also the optimization of its delivery, effectiveness, and potential toxicity. These developments demonstrate the increasingly close relationship between molecular research, technological innovation, and clinical oncology.

Overall, the combined evidence supports an integrated model of breast cancer control in which epidemiological surveillance, individualized risk assessment, prevention, early identification, precise diagnosis, molecular characterization, and therapeutic innovation form a continuous clinical pathway. The principal advance is therefore not confined to any single diagnostic technique, risk factor, or treatment, but lies in the growing capacity to connect these different areas of knowledge. Such integration offers a stronger basis for identifying those at greatest risk, reducing avoidable exposures, detecting disease under more favorable clinical circumstances, selecting treatments with greater precision, and adapting healthcare strategies to the biological and social diversity of the populations affected by breast cancer.

CONCLUSIONS

Breast cancer remains a complex global health problem whose effective control cannot depend on a single preventive measure, diagnostic procedure, or therapeutic intervention. The evidence examined in this review demonstrates that the disease emerges from a multifactorial context in which genetic susceptibility, age, reproductive and hormonal characteristics, environmental exposures,

lifestyle, and individual clinical conditions interact in different ways. Consequently, contemporary approaches should move beyond isolated risk factors toward integrated models capable of estimating susceptibility more accurately and translating that information into appropriate preventive and clinical decisions.

Distinguishing modifiable from non-modifiable determinants has important implications for prevention. Lifestyle interventions can contribute to reducing avoidable risk, but they cannot completely prevent a disease influenced by inherited, biological, and age-related factors. At the same time, non-modifiable characteristics have considerable clinical value because their recognition can identify individuals who may benefit from intensified surveillance, genetic assessment, or differentiated screening strategies. Risk assessment should therefore serve as a bridge between epidemiological knowledge and individualized preventive care.

Early detection remains one of the most important opportunities for improving breast cancer management, but its effectiveness depends on more than the availability of screening technologies. Timely recognition must be followed by diagnostic confirmation, adequate pathological and molecular assessment, access to specialized care, and appropriate therapeutic intervention. Delays or discontinuities at any point in this pathway can diminish the benefits expected from early detection. Breast cancer control consequently requires coordinated healthcare systems capable of converting an initial suspicious finding into timely and clinically meaningful action.

The growing understanding of breast cancer heterogeneity represents another decisive advance. Molecular biology, genomics, biomarkers, receptor characterization, signaling pathways, and other biological information have progressively changed the way the disease is classified and treated. Breast cancer can no longer be approached adequately as a uniform clinical entity. Tumors with apparently similar anatomical characteristics may differ substantially in biological behavior, prognosis, and therapeutic sensitivity, making precise characterization fundamental to contemporary clinical decision-making.

Personalized treatment emerges from this transformation as an integrating principle rather than merely as the application of novel therapies. Its value lies in combining disease stage, pathological characteristics, molecular profile, expected treatment response, potential toxicity, patient characteristics, and individual circumstances to select the most appropriate intervention. Established modalities such as surgery, radiotherapy, chemotherapy, and endocrine therapy coexist with targeted approaches and emerging technologies, expanding the possibilities for maximizing therapeutic benefit while avoiding unnecessary treatment burden.

The evidence also indicates that greater attention should be directed toward populations whose risk or clinical presentation differs from conventional patterns. Hereditary and early-onset disease, breast cancer in younger women, benign breast conditions associated with subsequent risk, and male breast cancer illustrate the limitations of uniform strategies. The future of breast cancer prevention and management therefore requires increasingly risk-adapted approaches capable of recognizing biological and population diversity.

Ultimately, the principal conclusion of this review is that progress against breast cancer depends on connecting knowledge that has traditionally been addressed in separate domains. Epidemiology identifies patterns of disease and vulnerable populations; risk assessment supports prevention and surveillance; early detection creates opportunities for timely intervention; precise diagnosis reveals clinically relevant characteristics; molecular characterization refines prognosis and therapeutic selection; and personalized treatment translates this accumulated information into patient-specific care. The integration of these components represents one of the strongest pathways toward reducing preventable risk, detecting disease at more favorable stages, improving therapeutic precision, minimizing unnecessary toxicity, and ultimately reducing the mortality and broader human burden associated with breast cancer.

REFERENCES

- American Cancer Society. (2026). *Breast cancer risk factors you cannot change*. <https://www.cancer.org/cancer/types/breast-cancer/risk-and-prevention/breast-cancer-risk-factors-you-cannot-change.html>
- Burke, A., O'Driscoll, J., Abubakar, M., Bennett, K. E., Carmody, E., Flanagan, F., Gierach, G. L., & Mullooly, M. (2025). A systematic review of determinants of breast cancer risk among women with benign breast disease. *npj Breast Cancer*, 11, 16. <https://doi.org/10.1038/s41523-024-00703-w>
- Cortiana, V., Kannan, S., Vallabhaneni, H., Gambill, J., Nadar, S., Jigar Kumar Rangrej, V., Park, C. H., & Leyfman, Y. (2025). Early and hereditary breast cancer: advances in risk stratification and imaging approaches. *Therapeutic advances in medical oncology*, 17, 17588359251349677. <https://doi.org/10.1177/17588359251349677>
- Escala-Garcia, M., Morra, A., Canisius, S., Chang-Claude, J., Kar, S., Zheng, W., Bojesen, S. E., Easton, D., Pharoah, P. D. P., & Schmidt, M. K. (2020). Breast cancer risk factors and their effects on survival: A Mendelian randomisation study. *BMC Medicine*, 18, 327. <https://doi.org/10.1186/s12916-020-01797-2>
- Feng, Y., Spezia, M., Huang, S., Yuan, C., Zeng, Z., Zhang, L., Ji, X., Liu, W., Huang, B., Luo, W., Liu, B., Lei, Y., Du, S., Vuppapapati, A., Luu, H. H., Haydon, R. C., He, T. C., & Ren, G. (2018). Breast cancer development and progression: Risk factors, cancer stem cells, signaling pathways, genomics, and molecular pathogenesis. *Genes & Diseases*, 5(2), 77–106. <https://doi.org/10.1016/j.gendis.2018.05.001>
- García-Sancha, N., Corchado-Cobos, R., & Pérez-Losada, J. (2025). Understanding Susceptibility to Breast Cancer: From Risk Factors to Prevention Strategies. *International Journal of Molecular Sciences*, 26(7), 2993. <https://doi.org/10.3390/ijms26072993>
- Giordano, S. H., Buzdar, A. U., & Hortobagyi, G. N. (2002). Breast cancer in men. *Annals of Internal Medicine*, 137(8), 678–687. <https://doi.org/10.7326/0003-4819-137-8-200210150-00013>
- Hoque, N., Choudhury, A., Baishya, D., & Deka, H. (2024). Comprehensive review of breast cancer risk factors, diagnosis, screening, and treatment methods. *Journal of Applied Pharmaceutical Research*, 12(5), 16–27. <https://doi.org/10.69857/joapr.v12i5.606>
- Küçükerdem, H. S., Yılmaz, C., & Gökdemir, Ö. (2026). Association of pre-diagnosis breast assessment practices and risk factors with breast cancer stage at diagnosis: A single-center cross-sectional study. *Journal of Clinical Medicine*, 15(16), 6288. <https://doi.org/10.3390/jcm15166288>
- Loibl, S., André, F., Bachelot, T., Barrios, C. H., Bergh, J., Burstein, H. J., Cardoso, M. J., Carey, L. A., Dawood, S., Del Mastro, L., Denkert, C., Fallenber, E. M., Francis, P. A., Gamal-Eldin, H., Gelmon, K., Geyer, C. E., Gnant, M., Guarneri, V., Gupta, S., ... Harbeck, N. (2024). Early breast cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up. *Annals of Oncology*, 35(2), 159–182. <https://doi.org/10.1016/j.annonc.2023.11.016>
- Løyland, B., Sandbekken, I. H., Grov, E. K., & Utne, I. (2024). Causes and risk factors of breast cancer, what do we know for sure? An evidence synthesis of systematic reviews and meta-analyses. *Cancers*, 16(8), 1583. <https://doi.org/10.3390/cancers16081583>
- Łukasiewicz, S., Czezelewski, M., Forma, A., Baj, J., Sitarz, R., & Stanisławek, A. (2021). Breast Cancer-Epidemiology, Risk Factors, Classification, Prognostic Markers, and Current Treatment Strategies-An Updated Review. *Cancers*, 13(17), 4287. <https://doi.org/10.3390/cancers13174287>
- Obeagu, E. I., & Obeagu, G. U. (2024). Breast cancer: A review of risk factors and diagnosis. *Medicine*, 103(3), e36905. <https://doi.org/10.1097/MD.00000000000036905>

- Roheel, A., Khan, A., Anwar, F., Akbar, Z., Akhtar, M. F., Khan, M. I., Sohail, M. F., & Ahmad, R. (2023). Global epidemiology of breast cancer based on risk factors: A systematic review. *Frontiers in Oncology*, *13*, 1240098. <https://doi.org/10.3389/fonc.2023.1240098>
- Sartaj, A., Qamar, Z., Qizilbash, F. F., Annu, Md, S., Alhakamy, N. A., Baboota, S., & Ali, J. (2021). Polymeric nanoparticles: Exploring the current drug development and therapeutic insight of breast cancer treatment and recommendations. *Polymers*, *13*(24), 4400. <https://doi.org/10.3390/polym13244400>
- Sharma, D. K., & Saripilli, R. (2025). Recent strategies in diagnosis, screening, prevention, and treatment of breast cancer in young women. *Discover Oncology*, *16*, 1532. <https://doi.org/10.1007/s12672-025-03180-0>
- Sun, Y. S., Zhao, Z., Yang, Z. N., Xu, F., Lu, H. J., Zhu, Z. Y., Shi, W., Jiang, J., Yao, P. P., & Zhu, H. P. (2017). Risk factors and preventions of breast cancer. *International Journal of Biological Sciences*, *13*(11), 1387–1397. <https://doi.org/10.7150/ijbs.21635>
- Winkler, M. C., & Hetjens, S. (2024). Risk Factors and Preventive Measures for Breast Cancer. *Journal of clinical medicine*, *13*(16), 4610. <https://doi.org/10.3390/jcm13164610>
- World Health Organization. (2025). *Breast cancer*. <https://www.who.int/news-room/fact-sheets/detail/breast-cancer>
- Zafar, T., Naik, A. Q., Kumar, M., & Shrivastava, V. K. (2022). Epidemiology and risk factors of breast cancer. In A. Q. Naik (Ed.), *Breast cancer: From bench to personalized medicine* (pp. 3–29). Springer Nature Singapore. https://doi.org/10.1007/978-981-19-0197-3_1
- Zehra, S. S., Turabee, Z., & Rawalia, M. A. (2023). Early but quality diagnosis: On breast cancer and its risk factors [Letter]. *Breast Cancer: Targets and Therapy*, *15*, 549–550. <https://doi.org/10.2147/BCTT.S431476>
- Zhang, Y., Lindström, S., Kraft, P., & Liu, Y. (2025). Genetic risk, health-associated lifestyle, and risk of early-onset total cancer and breast cancer. *JNCI: Journal of the National Cancer Institute*, *117*(1), 40–48. <https://doi.org/10.1093/jnci/djae208>

Conflicts of Interest:

The author declares no conflicts of interest.

Author Contributions:

Yalda Azimzadeh-Moghaddam: Conceptualization, data curation, formal analysis, investigation, methodology, supervision, validation, visualization, original draft writing, and writing, review, and editing.

Ethical statement:

The study was based on the analysis of documentary sources and publicly available data, and therefore did not involve the direct participation of human subjects. No personally identifiable information was handled.