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IMPACT OF DELAYED BREAST CANCER SCREENING ON STAGE DISTRIBUTION AT DIAGNOSIS: EXPERIENCE FROM A HEALTH SERVICE PROVIDER IN BARRANQUILLA, COLOMBIA

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ABSTRACT

Breast cancer is the most commonly diagnosed cancer in women worldwide, and inequalities in mortality between the high-income and the low and middle-income countries (LMICs) are growing. Although the incidence continues to increase in transitional economies, survival has not improved equally, much of this due to inequalities in screening infrastructure and the level of diagnosis. This review examines the influence of delayed or inadequate breast cancer screening on incidence patterns, stage migration, and mortality, with a focused contextual analysis of Barranquilla, Colombia. Evidence from randomised trials, modelling studies, and observational data demonstrates that interruptions in screening contribute to diagnostic delays, increased tumour size, higher rates of stage III–IV presentation, and subsequent mortality increases. Structural barriers within Colombia's EPS/IPS health system, socioeconomic inequalities, and institutional screening gaps further compound late-stage detection in Caribbean regions. Advanced-stage diagnosis imposes substantial clinical, economic, and psychosocial burdens, including higher mastectomy rates, increased chemotherapy utilisation, and escalating healthcare costs. Strengthening organised, population-based screening, improving policy coordination, leveraging technological innovations, and implementing community-based outreach are essential strategies to mitigate stage migration and reduce breast cancer burden in resource-constrained settings.

KEYWORDS: Breast cancer; Screening delay; Stage migration; Health system barriers; Latin America; Early detection.

1. GLOBAL AND REGIONAL EPIDEMIOLOGY OF BREAST CANCER

1.1 Global Burden of Breast Cancer

Breast cancer is the most commonly diagnosed cancer in the world today and the top reason of cancer related deaths amongst women. The latest GLOBOCAN 2020 estimates indicate that worldwide, about 2.3 million new cases of breast cancer were diagnosed in 2020, which is close to one in every four cancer cases in women. The mortality is also high, as it is estimated that 685,000 people die each year, which is an indication of ongoing inequality in access to early detection and treatment. Incidence rates are greatest in high-income countries (HICs), but mortality rates are unevenly distributed, with more individuals diagnosed with the disease in low- and middle-income countries (LMICs) at an advanced stage (Arnold et al., 2022).

The age-standardised incidence rates (ASIR) are quite different between regions, with rates being more than 80 per 100,000 women in some parts of Western Europe, North America, and Australia and lower than 40 per 100,000 in a number of African and South-Central Asian countries. Nevertheless, the epidemiological transition in LMICs has caused the gradual increase in the incidence rates, which has been caused by urbanisation, delayed childbearing, obesity, physical inactivity, and Western lifestyle patterns (Torre et al., 2017). Conversely, the trend of mortality has already been stabilised or decreased in most HICs within the last twenty years because of systematic screening programs and the development of systemic therapy (DeSantis et al., 2019).

Early detection is important, as evidenced by the difference in trends between incidence and mortality. Nations that have both properly developed mammography screening services have shown that the mortality rates of breast cancer are reduced by between 20% and 40%. In contrast, LMICs are facing a twofold burden, in which increased incidences are not matched by equal increases in survival, resulting in increasing disparities in the world (Allemani et al., 2018). The above world scenario highlights the need to reinforce screening systems in the transitional economies.

1.2 Latin American Trends

The risk of breast cancer has been growing continuously in Latin America during the last twenty years, which reflects the ageing of the population and the shift of people to a sedentary lifestyle. The regional ASIR values vary between 40 and 70 per 100,000 women, and they are higher in Argentina, Uruguay, and Brazil than in Andean and Central American states. Compared to North America or Europe, the incidence of TB is moderate; however, basal mortality-to-incidence ratios (MIRs) in Latin America are very high because of late diagnosis and low coverage of screening (Sharma, 2019).

Population-based screening programs are poorly organised and not uniformly applied in the region. Although national guidelines in the country suggest that women aged 50-69 should have their mammography once every two years, the attendance rate is usually less than 50. Unequal access to diagnostic services is associated with such factors as socioeconomic inequality, disjointed health systems, and urban-rural differences. Screening in most contexts is non-systematic, but opportunistic, and thus not very effective at impacting a population in general.

The stage at diagnosis also reflects the regional challenge. In Latin America, the studies indicate that up to 40-60% of the women are diagnosed with the stage III or IV disease, as opposed to under 30% of the nations in Western Europe. This increase in incidence and continued presentation in its later stages implies that the availability of early detection mechanisms has not increased with the required epidemiological demand. Therefore, the decreases in the mortality of breast cancer in Latin America have been lower and less intense in comparison to HICs (Ginsburg et al., 2020). The relevance of these trends is that screening infrastructure has to be reinforced and structural obstacles minimised within the context of middle-income countries.

1.3 Breast Cancer in Colombia

Breast cancer is the most prevalent tumour in women and the leading cause of cancer-related mortality in Colombia. The data provided by the National Cancer Institute and population-based cancer registries estimate an ASIR of about 4855 per 100,000, with the regional difference in the departments. The mortality rates have been rising slowly in the last 10 years, especially in the Caribbean and Pacific areas (Valbuena-Garcia et al., 2025).

Distribution at diagnosis at this stage is a matter of concern. According to Colombian registry data, approximately 45-50% of women appear with stage II disease, 20-30% with stage III or IV (Allemani et al., 2018). Women who are members of subsidised insurance regimes and those who are living in rural or peripheral urban regions tend to be diagnosed at a late stage. These outcomes are increased by differences in the length of diagnosis and referral.

The net survival rate of breast cancer in Colombia over the past five years has moderately increased, but is still low compared to the high-income countries. The survival estimate with CONCORD-3 data is about 70-76%, whereas the survival is more than 85% in North America and Western Europe (Allemani et al., 2018). Stages at diagnosis, more than the biological distribution of subtypes, contribute to a great part of the differences. Even though the national guidelines prescribe the mammography screening of women aged 50 to 69 every two years, the enforcement of this screening depends on the insurance provider and the geographic location. These results indicate that the improvement of early detection routes can considerably increase the national survival rates.

1.4 Regional Context: Barranquilla and Caribbean Colombia

The capital of the Atlantico Department, Colombia, in its Caribbean region, is known as Barranquilla and is a replica of many of the structural inequities witnessed throughout the country. Cancer surveillance reports demonstrate an increase in the level of breast cancer cases in the last ten years, and the death rates in certain municipalities are above the national average (WHO, 2024). The concentration of specialised oncology services in urban areas is opposite to the inaccessibility of these services in the periphery, which establishes bottlenecks in diagnoses.

The Colombian health system works based on mixed insurance (EPS/IPS), according to which preventative services are heavily contingent on authorisation and efficiency of referrals. Caribbean departments have been reported to have delays in the scheduling of mammography and biopsy, which have led to long diagnostic periods. In addition, socioeconomic vulnerability and poor health literacy can decrease the attendance of screening programs on a regular basis.

Regional provider observations institutionalised in institutions such as the League against Cancer in Barranquilla are indicating that in recent years, there have been observed population changes in terms of increased symptomatic presentation and advanced diagnosis. In spite of the lack of extensive population-based data, preliminary institutional patterns reveal that the rates of screening uptake decline in situations of health system disruptions and then there is an increase in the number of detected cases. This localised scenario gives a critical basis for the study of the potential effect of delayed or insufficient screening on the rising prevalence of breast cancer among this group. Table 1 summarises regional variations in the incidence, mortality, survival and screening coverage. The differences between the stage at diagnosis and mortality in different regions of the world tend to indicate the differences in the strength of the screening systems (Figure 1).

Table 1. Age-standardised breast cancer incidence and mortality rates (Global vs Latin America vs Colombia)

Region	Incidence (per 100,000)	Mortality (per 100,000)	5-year Survival (%)	Screening Coverage (%)
Global Average	~47	~13	~75	Variable
Latin America	40–70	13–18	65–75	<50% in many countries
Colombia	48–55	14–16	70–76	~45–55% (estimated)

Sources: (Allemani et al., 2018; Bray et al., 2018; WHO, 2024).

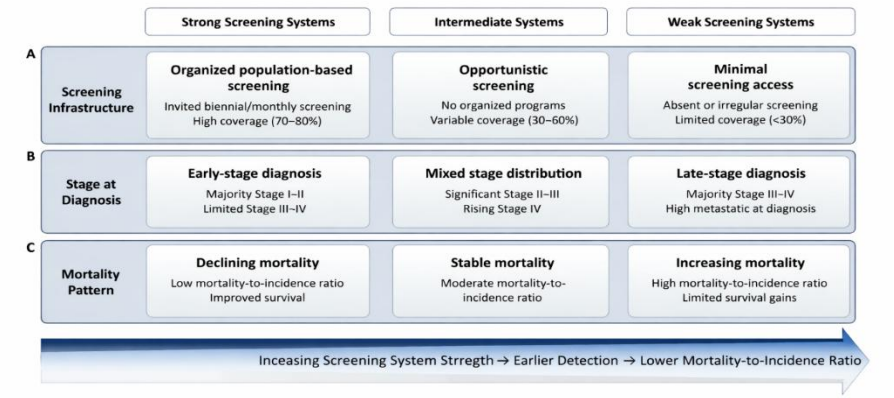

Figure 1. Global breast cancer outcome gradient across screening system strength.

2. BREAST CANCER SCREENING: PRINCIPLES, GUIDELINES, AND EFFECTIVENESS

2.1 Tumour Biology and Rationale for Early Detection

The development of breast cancer is typified by a long preclinical period when the tumours are asymptomatic and detectable by radiography. The doubling time of tumours differs significantly, between about 50 and more than 200 days, depending on the molecular subtype, the age of patients and tumour biology. The tumours that have hormone receptors usually show reduced growth kinetics than triple-negative or HER2-positive ones, as the latter have a tendency to develop faster. The impact of this biological heterogeneity on the ideal window of screening and interval cancer probability.

Screening effectiveness revolves around the notion of the so-called preclinical detectable phase (PCDP). The tumours during this window are large enough to be observed with the help of imaging, but have not yet resulted in symptoms. Based on modelling studies, the average sojourn time, PCDP, falls between 2 and 4 years of age among women 50-69 years old, which supports the idea of bi-annual mammographic screening in women (Shen & Zelen, 2001). Probably, early diagnosis at this stage provides a high likelihood of the diagnosis of the tumours at stage I, where survival over five years is more than 90% in most environments.

In the absence of screening, the tumours tend to manifest in larger sizes and in the nodes. It has been proven that there is a close relationship between the size of the tumour at the time of diagnosis and metastasis risk. Thus, it is not only that in this way, more cancers are found, but that the screening is more likely to be performed at earlier stages, making it less likely to have systemic dissemination and leading to better long-term outcomes (Esserman et al., 2013).

2.2 Screening Modalities

Mammography

Mammography is the gold standard of population-based screening of breast cancer. Its ability to decrease breast cancer mortality has been proven through randomised controlled trials (RCTs), as well as long-term follow-up studies, especially in women aged 50 to 69. The digital mammography technology has mostly superseded the film-based technology with better image storage and slightly higher sensitivity, particularly in younger women with dense breasts (Berg et al., 2012).

Digital Breast Tomosynthesis

Digital breast tomosynthesis (DBT), also known as 3D mammography, offers stacked visualization which reduces the tissue overlap and enhances the visualisation of lesions. Research has indicated that DBT leads to higher cancer detection and lower recall rates than conventional digital mammography. Meta-analyses propose a better observation of invasive cancers, but long-term mortality data are still low (Miglioretti et al., 2019).

Ultrasound

The breast ultrasound is often taken as the complementing modality, especially in women who have dense breast tissue. Ultrasound supplement has been reported to augment the detection of small cancers that have not been seen in mammography and have no nodes (Berg et al., 2012). It has a limitation on its application in population-wide screening, however, because it relies on operator bias and increases false-positive rates.

Magnetic Resonance Imaging (MRI)

The breast MRI has the best sensitivity among imaging modalities and is suggested for most high-risk groups, such as BRCA mutation carriers (Kuhl et al., 2017). The MRI screening is better in the detection of early cancer in women with genetic predisposition, but is constrained by the cost and specificity issues.

Artificial Intelligence (AI)-Based Detection

AI-assisted image interpretation is emerging as a promising adjunct to radiologist assessment. Studies indicate that AI algorithms can achieve sensitivity comparable to that of experienced radiologists while potentially reducing workload and false-negative rates. Implementation in organised screening programs may improve efficiency, particularly in resource-constrained settings. However, external validation and cost-effectiveness analyses are ongoing (Rodriguez-Ruiz et al., 2019).

Combined, these modalities create a tiered screening strategy with mammography as the foundation, and supplementary technologies increasing the detection in special groups of the population.

2.3 International Guidelines

Breast cancer screening policies have minor differences across the globe, but all the policies agree on the value of regular mammography in women between the ages of 50 and 69 years. According to the recommendations of the World Health Organisation (WHO), population-based mammography screening

should be organised and carried out in a well-resourced environment with a focus on quality assurance and monitoring of the program (WHO, 2024). On the contrary, opportunistic screening has been deemed to have poor performance because of the lack of uniformity in participation.

Recently, the U.S. Preventive Services Task Force (USPSTF) revised its recommendations in favour of regular screenings of mammography, this time a biennial test in women aged 40 to 74, but with a Grade B recommendation (US Preventive Services Task Force et al., 2024). This change is in keeping with the growing body of evidence that an earlier onset could have less mortality in 40-year-old women. Screenings should be done once every year beginning at the age of 45-54, then once every 2 years (at 55 and above), and then at age 40 (where it may be initiated) at the recommendation of the American Cancer Society (ACS) (Oeffinger et al., 2015).

European Commission recommends that women aged 50-69 years be screened every 2 years as part of organised programs that have a high-quality control level (European Commission Initiative on Breast Cancer, 2026). European standards are focused on the centralised registries and performance indicators in order to make it effective.

The national guidelines in Colombia suggest that mammography for women between 50 and 69 should be done on a bi-annual basis as part of the national cancer control plan (Ministerio de Salud y Protección Social, 2019). Nevertheless, the application is usually discrete and relies on the authorisation of insurance, thus restricting fair practice.

Despite minor differences in the display of the age limit, the most significant agreement among most major organisations points to the fact that the best evidence-based approach to reducing the mortality of breast cancer is the structured mammography programs that are of high quality.

2.4 Evidence from Randomised Controlled Trials and Meta-Analyses

The success of mammography screening has been tested in several RCTs carried out in Europe and North America. The Swedish Two-County Trial showed that mortality rates of breast cancer were reduced by 30% in women called to the screening. Further aggregated studies showed mortality rates decreased 20 to 25% among 50 to 69-year-old females (Marmot et al., 2013).

Follow-up data have shown that screening not only lowers the mortality rate, but also leads to migration of the stage, which enhances the percentage of cancers that are detected at stage I and reduces the number of cancer stages with an advanced diagnosis. According to modelling research, screening and more effective systemic treatments both help reduce mortality by around 37 to 50% of reported decreases in certain groups (American Cancer Society, n.d.).

Screening, however, does not go without controversy. The problem of overdiagnosis, i.e., the identification of tumours that are not going to lead to a life-threatening situation in a patient, is controversial. The estimates of overdiagnosis are highly variable (between 5% and 30%), depending on the methodology and population under analysis. Those who oppose it believe that patients can receive unneeded treatment as a result of overdiagnosis, whereas those who support it assume that the reduced mortality is more important than these risks (Hofmann et al., 2021).

Altogether, good evidence base confirms that mammographic screening is an efficient intervention in the population. Screening of women aged 50-69 years has been proven to be very effective in reducing presentations and deaths of breast cancer at the advanced stage, especially when carried out among organised systems that have quality assurance measures. Table 2 defines the main differences and similarities between the international recommendations on breast cancer screening.

Table 2. International Breast Cancer Screening Recommendations

Organization	Starting Age	Frequency	Risk Stratification	Strength of Recommendation
WHO	50 years	Biennial	Population-based	Conditional (resource-dependent)
USPSTF (US Preventive Services Task Force et al., 2024)	40 years	Biennial	Average risk	Grade B
ACS (American Cancer Society, n.d.)	45 years (option at 40)	Annual (45–54), Biennial ≥55	Average risk	Strong
European Commission (European Commission Initiative on Breast Cancer, 2026)	50 years	Biennial	Organised population-based	Strong
Colombia (Ministry of Health)(Ministerio de Salud y Protección Social, 2019)	50 years	Biennial	Average risk (organised/opportunistic)	National guideline

3. IMPACT OF DELAYED OR INADEQUATE SCREENING ON INCIDENCE AND STAGE AT DIAGNOSIS

3.1 Conceptual Framework of Delay

Breast cancer diagnosis is a continuum of events which relies on scanning initially in screening without any symptoms and eventually leading to a conclusive treatment. Delays can be at various levels and are generally divided into patient delay, provider delay and system-level delay. Patient delay can be defined as the interval occurring between the onset of symptoms and attendance at a medical facility, which is usually affected by literacy levels, health beliefs, culture, or socioeconomic conditions (Facione, 1993). Conversely, system delay includes the inefficiencies of healthcare infrastructure, such as the long waiting time in imaging, biopsy, reporting pathology and referring specialists (Sullivan et al., 2011).

The quality indicator that has become very crucial is the diagnostic interval, which is the time taken between the initial healthcare contact and the diagnosis. This is because extended periods of diagnostic time are closely related to the size of the tumours and the presence of more nodal involvement when starting treatment. Although in asymptomatic populations, disruptions in routine screening alone are effective to propel people off a preventative pathway into a symptomatic pathway, which escalates the chances of detection at an advanced stage.

Biologically, the delay phase of tumour progression is not linear, but exponentially related; that is, minimal changes in time can be matched by massive changes in tumour volume (Friberg & Mattson, 1997). The preclinical detectable phase can pass without being discovered when screening programs are interrupted by disruption of the health system, lack of resources or external crisis. This results in a domino effect: screening breakage, early detection, high-grade tumour, later diagnosis, high-stage tumour, and risk of death.

Detection of disruption triggers a cascade of tumour development to the advanced stages of diagnosis and increased mortality (Figure 2).

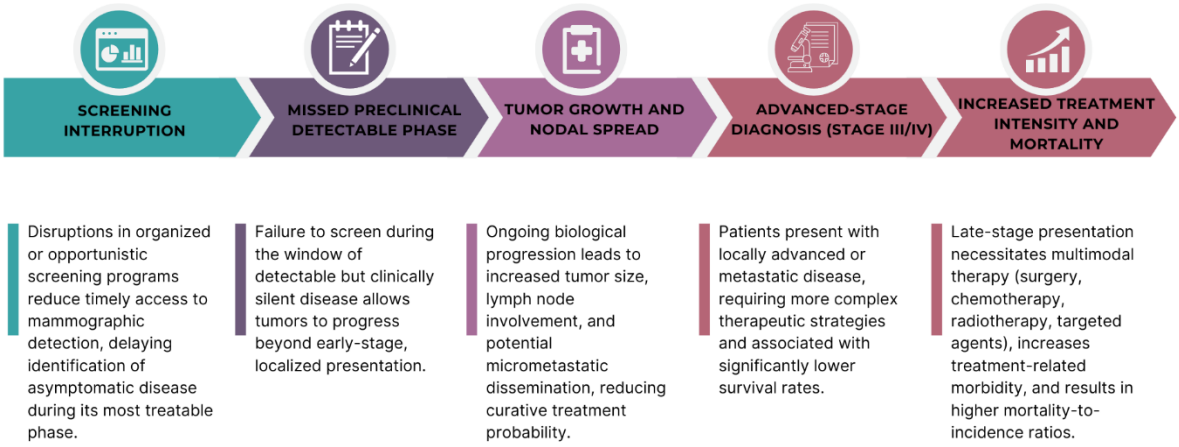

Figure 2. Conceptual model of delay in breast cancer diagnosis.

3.2 Screening Gaps and Apparent Incidence Increase

Ironically, the postponed screening might first cause a short-term decrease in reported cancer incidence, which will be compensated for by the increase when the services are restarted. This is the effect of the backlog when the diagnostics of the cases remained incomplete throughout the interval (Dinmohamed et al., 2020). In situations where a screening program is resumed, these hitherto unidentified tumours are diagnosed during a condensed period of time, giving the impression of an abrupt increase in incidence.

The rebound effect has been recorded in various environments after discontinuities in healthcare. There was a study by European screening registries that showed that even temporary breaks led to a substantial rise in detected cancers in the next screening round. Notably, a large number of these cases were diagnosed to be larger than what most uninterrupted programs tend to be.

There can also be detection surges that distort the interpretation of epidemiology. The rise in the number of cases can be interpreted as an actual increase in the disease incidence, when it is actually a latent disease discovery. Nonetheless, long-term or frequent screening disruptions may also be a cause of real advancement in high-stage incidence, as tumours escalate to phases that are not readily

identifiable.

Even small disruptions in the LMIC contexts, where participation in screening is already not optimal, can worsen already existing gaps. The opportunistic screening systems are also susceptible because they do not have a centralised method of recall to re-engage the missed populations (Trisolino et al., 2023). Thus, screening gaps have an impact on both the immediate incidence trends and the long-term distributions of any stage, making the planning of health systems and resource allocation difficult.

3.3 Stage Migration and Advanced Disease Increase

Migration of the stage to a higher stage is one of the most common outcomes of late screening. A number of analyses on populations have demonstrated that disruptions in screening correlate with an evaluable rise in stage III and IV diagnoses (Sharpless, 2020; Yong et al., 2021). In the modelling cases that model a six- to twelve-month delay in screening, researchers estimated that there would be a 5-10% point rise in the occurrence of advanced-stage presentation over the years.

The size of the tumour at diagnosis is a very sensitive delay indicator. Research comparing periods greater than three months has shown that there are vast differences in the mean tumour diameter compared to those cases diagnosed in the short period. The size of the tumour is also directly proportional to the rate of involvement of the axillary lymph nodes, which continues to be a significant determinant of prognosis.

The statistics of interrupted screening programs demonstrate a decrease in the rate of detection in stage I and a corresponding increase in stage II-III cancer. Even small changes in stage have significant population-level survival consequences. As an illustration, the decrease of early-stage diagnosis by 10% can result in hundreds of unnecessary deaths every year in mid-sized populations. (Hanna et al., 2020).

Multimodal treatment, such as chemotherapy, mastectomy and radiation therapy, which are aggressive methods of treating advanced-stage disease, are also more expensive and raise toxicity. Notably, the already biologically aggressive triple-negative and HER2-positive tumours can develop quickly when there is a screening break, which worsens the imbalances (Ensenyat-Mendez et al., 2021).

Therefore, stage migration is a quantifiable outcome of screening delay that is clinically significant. It gives a direct correlation between the disruption in the service and the increase of mortality in the long term, which contributes to the need to have uninterrupted early detection programs.

3.4 COVID-19 Screening Disruption Evidence

The COVID-19 pandemic presented a natural trial that showed the susceptibility of cancer screening systems. In March-June 2020, a large number of countries halted the organised screening programs of breast cancer to minimise the spread of the virus and redistribute health resources. In the US, the volume of mammographies decreased by up to 89% in the early months of the pandemic (Miller et al., 2021). Reductions of this degree were felt in Europe and in some regions of Latin America.

The pre-established constraints on resources increased the difficulties that Latin American states had to face. In Brazil and Mexico, it was reported that mammography coverage declined significantly at the end of 2020 and has not fully recovered in the next few years. The delays were disproportionately experienced by the low-income groups, which may increase the disparities in health.

Estimates in the modelling studies suggest that screening disruptions associated with a pandemic may lead to thousands of new deaths due to breast cancer in the coming decade unless mitigation measures are put in place (Alagoz et al., 2021). Backlog and delays in diagnoses are still common in most areas despite a general reinstatement of screening services.

The pandemic revealed flaws in the organisation of opportunistic screening systems and the necessity of having resilient and structured programs that will not collapse after disruption.

3.5 Long-Term Mortality Implications

It is predicted that even mortality changes due to short-term screening delays can be observed within 5-10 years. High-income microsimulation models run the estimation that a six-month break in screening would raise the number of deaths because of breast cancer by around 1 to 2%, whereas a twelve-month break could lead to 3 to 5% excess death (Poelhekken et al., 2023). These percentages may seem small, but on the population level, they can be expressed in large absolute numbers.

The effect of mortality is not immediate but is a gradual process because stage-shifted cases develop. The cumulative burden is increased because women who are diagnosed with the disease at stage III have a significantly lower five-year survival than women who are diagnosed at stage I (De Lemos et al., 2019). Moreover, the treatment progress is not enough to

offset the late diagnosis, especially in aggressive forms of tumours.

In LMICs, with a high current baseline late-stage diagnosis, further screening delays could be proportionately more important. Hence, the continuity of screening services is not only important to detect cases in the long term but also in terms of survival. Table 3 demonstrates the relationship between screening disruption and stage migration and excess mortality using empirical and modelling evidence.

Table 3. Evidence Linking Screening Delay to Stage Shift and Mortality Increase

Study	Country	Screening Disruption Duration	Increase in Stage III/IV (%)	Projected Excess Deaths
(Maringe et al., 2020)	UK	3–6 months	+7–9%	~1,100 excess deaths (10 yrs)
(Sud et al., 2020)	UK	6 months	+5–8%	3–5% mortality increase
(Alagoz et al., 2021)	USA	6–12 months	+6–10%	~5,000 excess deaths
(Yong et al., 2021)	Canada	6 months	+5%	Significant stage shift
(Rottoli et al., 2022)	Italy	4 months	+8% advanced stage	Not modeled

4. STRUCTURAL AND SOCIOECONOMIC BARRIERS IN BARRANQUILLA

4.1 Colombian Health System Structure

Colombia has a mixed insurance-based health system, which is founded on Entidades Promotoras de Salud (EPS) and Institutos Prestadoras de Servicios (IPS) model, which was instituted by Law 100 of 1993. EPS entities are risk pooling and authorisation of services insurers, whereas IPS institutions offer direct clinical services. Despite successful coverage in the system in the past number of years, insurers and provider dispersion has led to administrative complexity, especially in the field of preventive care (Bernal & Forero, 2015).

Funding of preventive care is still disproportionally allocated in contrast to curative care. The monetary investment tends to offer monetary benefits to expensive treatment interventions instead of an early detection framework and diminishes a long-term investment in structured screening. Mammography screening is part of the national benefit packages, but access depends on the authorisation procedures that can postpone the scheduling and referral (Valbuena-Garcia et al., 2025).

Moreover, the decentralisation of health governance has made the disparities among regions in terms of implementation ability. Many Caribbean departments, such as Atlántico, often have problems with infrastructure and the shortage of oncology workers compared to large metropolitan centres, like Bogotá and Medellin. There can be administrative authorisation barriers, reimbursement delays, and provider network fragmentation, and these may all increase the period of diagnosis.

Notwithstanding the policy structures that advocate the use of biannual mammography in women between the ages of 50 and 69 years, the practice is usually not population-based but rather impromptu. This structural feature leads to the heightened susceptibility of service breakdown, and it adds to uneven screening uptake by region.

4.2 Access Barriers

Barraquilla has logistical and infrastructural constraints on the accessibility of breast cancer screening. Wait times of appointment to mammography and follow-up imaging may exceed the recommended duration, especially in subsidised insurance systems. The lack of appointment slots and the administrative need to approve the service are common ways of compounding the delays.

Another important barrier is represented by diagnostic backlogs. The scheduling of biopsies and pathology reporting may take weeks following abnormal mammography results, which prolongs the timeframe of diagnosis, which should not be under the best timelines. According to international standards, diagnostic confirmation is best achieved within 30 days, but in some populations, it takes more than 60 days before it can be confirmed (Duarte et al., 2021).

The access is also affected by limitations in equipment. Despite the tertiary care institutions in Barranquilla, the distribution of mammography units may be uneven between the districts, which restricts the provision of the required services to the peripheral populations (Duarte et al., 2021). Problems in maintenance and shortage of staffing, especially trained radiologists and breast imaging

specialists, additionally limit the service capacity.

The indirect costs, such as lost wages and transportation barriers, disproportionately impact low-income women. Although screening is supposed to be free, it may not encourage participation due to other related costs. These access restrictions bring about accumulating delays, which move the diagnosis to a symptomatic and later presentation.

4.3 Socioeconomic Determinants

Socioeconomic inequality is a serious factor that determines the outcomes of breast cancer in Colombia. The level of education is closely related to screening participation, where women who have high levels of formal education are most likely to attend preventive health services (Barrios et al., 2018). Lack of awareness of screening recommendations is also a contributing factor to underutilization, especially among women in the informal sectors of employment.

Another determinant is the insurance type. The contributory insurance regimes and subsidised insurance regimes of Colombia vary in terms of administrative procedures and provider systems. Female patients on subsidised plans tend to have a higher wait time for authorisations and have less access to specialised diagnostic services. Research has shown that the stage at diagnosis is much superior in women who are covered in the subsidised regime than in contributory affiliates (Chen et al., 2007).

Healthcare-seeking behaviour is also determined by cultural perceptions and stigma regarding cancer. Caribbean populations have been reported to have a fear of diagnosis, misconceptions of treatment, and fatalistic beliefs. The attitudes can make the presentation slow following the acknowledgement of symptoms.

The socioeconomic inequalities in Barranquilla match the geographic inequalities in its heterogeneous urban setting. Compounded barriers may emerge in peripheral communities, such as poor education, informal jobs and limited access to health care. These predictors lead to late screening and higher chances of a late diagnosis.

4.4 Institutional Data from the League Against Cancer

The League against Cancer, which has been conducting institutional observations in Barranquilla, is useful in understanding the nature of screening in the region. Even though the overall population-based registry data have not been comprehensive, institutional records indicate that the volume of screening has increased and decreased over the past few years. Interestingly, decreases in mammography uptake in changes to the healthcare system were associated with higher detection of symptomatic cases.

First initial internal data show that there is a change in stage distributions before and after the periods of disruption. Before the service interruptions, the diagnoses were made in a higher proportion at stages I-II. After the decrease in screening activity, the share of stage III–IV diagnoses was on the rise, which is aligned with the stage migration trends in other countries (Horton et al., 2020).

There were also diagnostic delays. The time interval between abnormal imaging and histopathological confirmation showed an increase in times of strain in the system, and this reflects the administrative and logistical bottlenecks. The more palpable masses were presented and not the lesions detected by screening, further contributing to the hypothesis that opportunistic detection substituted regular screening at gaps in services.

Such institutional trends coincide with national and international evidence which describes a relationship between screening interruption and a late presentation. Although additional quantitative investigation is justifiable, the data collected by the League highlights the very real effect of structural and socioeconomic barriers on early detection. The establishment of structured screening channels and cutting short on consenting time can be very important in countering the perceived change in stages in the region. Table 4 demonstrates institutional tendencies in the volume of screening, distribution of stages and the intervals of diagnosis in Barranquilla.

Table 4. Institutional Trends at the League Against Cancer (Barranquilla)

Year	Number of Screening Mammograms	Stage I-II (%)	Stage III-IV (%)	Average Diagnostic Delay (days)
2018	4,850	68%	32%	28
2019	5,120	70%	30%	26
2020	3,100	60%	40%	45
2021	3,750	58%	42%	48
2022	4,300	63%	37%	35

5. HEALTH SYSTEM AND CLINICAL CONSEQUENCES OF LATE DIAGNOSIS

5.1 Clinical Consequences

Diagnosis of breast cancer at late stages significantly changes the course of treatment and clinical outcomes. Females diagnosed at stage III or IV have much greater chances of undergoing mastectomy as opposed to breast-conserving surgery because they have a bigger tumour, multicentric disease, or more involvement of the nodal metastasis. Conversely, early (I–II) cancer can be treated with lumpectomy and adjuvant radiotherapy, and this treatment preserves body image and minimises surgical morbidity (Barrios et al., 2018).

Systemic chemotherapy is also required in the case of advanced-stage disease. Although adjuvant chemotherapy is selectively administered in the early disease occurrence, depending on the tumour biology, stage III and IV cancer often require neoadjuvant or palliative chemotherapy. Higher toxicity profiles, such as cardiotoxicity, neuropathy, and functional impairment caused by these regimens, are long-term.

With the advancement of stages, the prognosis gets worse. Five years of survival is over 90% and decreases to about 70% and under 30% of stage III and stage IV metastatic disease, respectively, in most populations (Siegel et al., 2023). The strong independent predictors of mortality are lymph node positivity, as well as distant metastases. Moreover, the late-life presentation makes the recurrence more likely, as it will demand longer-term surveillance and further treatment.

This is also diminished by delayed diagnosis, although the less invasive target therapies are less effective in curative settings. Although there have been improvements in therapeutic advancements, which have benefited metastatic survival, the survival benefits of early detection are not adequately compensated. Therefore, the late diagnosis is not only a worsening factor in clinical outcomes, but it also complicates the treatment burden and survivorship in the long run.

5.2 Economic Burden

Breast cancer at an advanced level comes with significantly higher direct medical expenses than the early-stage disease. Research done in high and middle-income contexts always shows that the price of treatment grows exponentially as the stage advances (Blumen et al., 2016). Management of the disease at an early stage is usually managed with surgery and limited adjuvant therapy, whilst late management is usually managed with long-term systemic therapy, hospitalisations, and complications.

The cost comparative analysis indicates that managing stage III and IV breast cancer can be two to four times higher than stage I-II breast cancer treatment in a period of five years. The costs are prompted by chemotherapy treatment, targeted biological therapy, sophisticated imaging, and supportive care. Metastatic disease also adds to expenditure because of the repetitive courses of treatment and palliative treatment.

In LMICs, the economic burden goes beyond the direct medical expenses to also encompass devastating household spending and loss of productivity. Society is affected indirectly by absenteeism and the burden of care on the workforce. It has been proven through economic modelling that, in terms of life-years saved and decreasing the cost of late-stage treatment, organised screening programs are cost-effective. This includes the consideration of overdiagnosis and false positives; the cost-effectiveness ratios of such interventions are usually within the acceptable limits of interventions in the field of public health (Remak & Brazil, 2004).

In Colombia, the allocation of resources towards early detection can curb oncology spending in the long term. Timely screening prevents the migration of the stages, avoiding high-cost systemic therapies and in-hospital care. Hence, screening is not merely a clinical expenditure, but it is also a cost-saving business model to curtail the increasing expenditure on cancers in healthcare.

5.3 Psychosocial and Institutional Impact

In addition to clinical and economic outcomes, the diagnosis of breast cancer at its late stage has strong psychosocial implications. The latter disease is related to poor health-related quality of life, greater psychological distress, and greater anxiety and depression (Montazeri, 2008). Disturbance in body image and sexual dysfunction are more prevalent after mastectomy and rigorous chemotherapy than breast-conserving strategies (Group, 2012).

Psychosocial burden is also made worse by metastatic disease because patients are faced with chronic treatment, uncertainty, and end-of-life issues. Caregiving is often a responsibility of a family member, which causes emotional and financial burden. The inequity in survivorship increases when the diagnosis is made at advanced stages, especially in socioeconomically disadvantaged groups (Avis et al., 2004).

At the institutional level, advanced presentation elevates the pressure on the oncology services, which

overloads the hospitals. Multidisciplinary management (medical oncology, radiation oncology, surgery, palliative care, and supportive services) is needed in case of an advanced disease. Greater complexity of treatment will prolong the duration of appointments and the use of resources.

Expansion of the waiting list is a side effect of the delay in diagnosis and migration of the stage. Scheduling bottlenecks increase with the number of patients who need systemic therapy and inpatient treatment. This demand and supply cycle can also push back patients who have just received their diagnosis, further increasing the inefficiencies in the health system.

In the case of the League Against Cancer in Barranquilla, more cases at an advanced stage may lead to redistribution of resources between preventive treatment and high-cost treatment, which deter long term cancer control strategies. Thus, a late diagnosis is a clinical issue as well as a systemic challenge that influences the sustainability of healthcare.

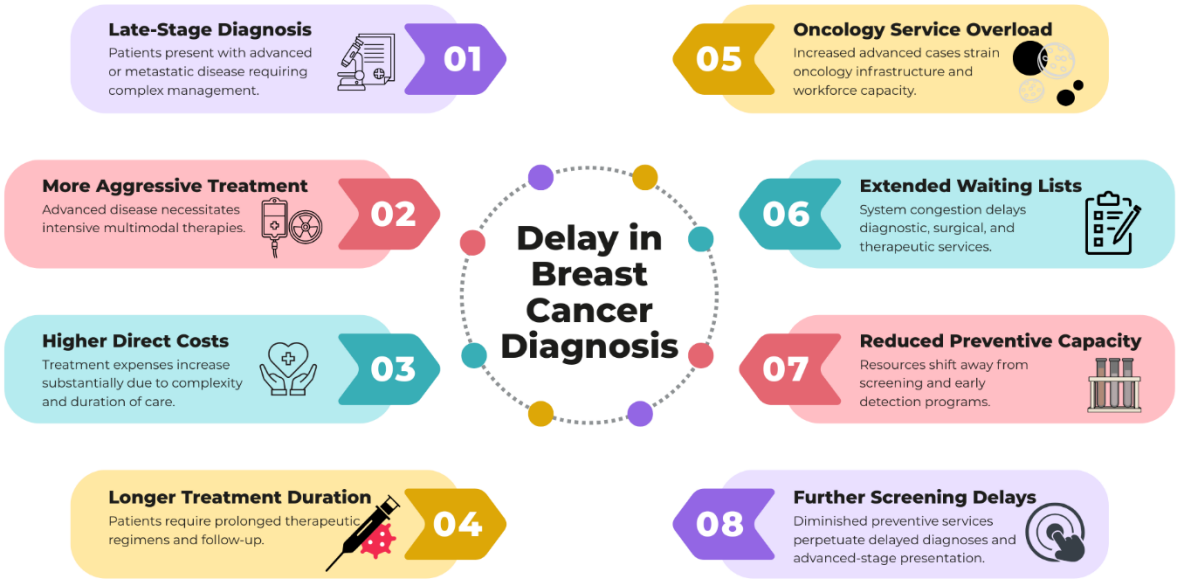

Figure 3. Downstream consequences of late-stage breast cancer diagnosis.

6. STRATEGIES TO IMPROVE TIMELY SCREENING AND REDUCE BURDEN

6.1 Organised Population-Based Screening

Population-based screening programs are always linked with increased rates of participation and reduction of mortality compared to opportunistic systems (DeSantis et al., 2019). Invitation systems that are registry-based, where potential women are identified and recalled on a pre-determined basis, enhance compliance and decrease access disparities. Participation, rates of recalls, interval cancers, and distribution of stage can be tracked centrally, and this allows continuous quality improvement (Perry et al., 2008).

To move towards opportunistic to organised screening in the middle-income context, it is necessary to invest in information systems and provider coordination. There is also evidence to support that structured invitation and recall systems help to decrease inequalities in screening uptake, especially in socioeconomically disadvantaged women (Baron et al., 2008). The potential benefits of implementing such systems in Colombia are to enhance continuity of care and keep screening services safe in future disruptions.

6.2 Policy-Level Interventions

The policy frameworks are key to the maintenance of early detection programs. NCCPs are strategic in terms of prevention, screening, treatment, and survivorship (WHO, 2024). Several countries that adopt structured screening as part of the overall cancer control measures exhibit greater reductions in deaths (Atun et al., 2015).

In Colombia, administrative delays in permitting mammography and biopsy can be lessened by increasing regulatory control over EPS entities. Stage migration could be countered by policy modifications that simplify the referral channels and implement a limit on diagnostic time. Also, the

inclusion of cancer screening indicators in national health information systems helps to improve transparency and accountability (Ginsburg et al., 2020).

Sustainability is based on the aspect of integrating screening into universal health coverage systems, whereby equal access must be granted regardless of the insurance coverage. Strong policy commitment is thus the key to maintaining the continuity of screening and lowering the burden at late stages.

6.3 Technological Solutions

There would be a good prospect in technological innovation to enhance the efficiency and accessibility of screening. Mammography interpretation aided by artificial intelligence (AI) has proven to improve the process of cancer identification and decrease the workload of radiologists. Artificial intelligence could enhance the ability to detect small lesions and decrease false negatives, especially in large-volume environments (McKinney et al., 2020).

Mobile mammography units offer an efficient approach to underserved or geographically remote groups of people. Research has proven that mobile services enhance screening rates among low-income women and the rural population. The barriers to transport could be reduced by deploying mobile units in peripheral areas of Barranquilla to enhance equity.

Although technological solutions demand initial spending, their incorporation into systematic screening initiatives can enhance resiliency and sustainability. Integrating AI, mobile units, and tele-radiology can assist in the optimisation of resource use and in decreasing diagnostic delays in the middle-income setting.

6.4 Community-Based Strategies

The involvement of the community is critical in enhancing screening attendance. Misconception, the importance of curability of the disease at early stages, and the creation of awareness of the recommended screening intervals through education campaigns have been found to increase the uptake of mammography (Baron et al., 2008). Personalised messaging based on culture is very successful among a variety of urban citizens.

Community health workers may also act as credible agents who can fill the gaps between vulnerable communities and healthcare institutions (Weller et al., 2012). The implementation of community-based outreach in the municipal health programs in Barranquilla can be used to improve screening services and minimise disparities in early diagnosis.

6.5 Recommendation for Barranquilla

In the case of Barranquilla, a specific recovery plan should be developed in order to deal with the screening backlog and stage migration. To reduce delays cumulatively, prioritising those women who missed their scheduled mammograms due to previous service disruptions is possible. Resource allocation may be optimised through risk-stratified outreach, i.e., targeting women aged between 50 and 69 years, as well as having a family history.

Installing registry-based monitoring in organisations like the League Against Cancer can facilitate the use of data in making decisions. Monitoring the coverage of screening, the interval of diagnosis, and the distribution of the stage will help in identifying the lapses in the service. The collaboration between EPS insurers and IPS providers must facilitate the process of authorisation and minimize the administrative obstacles.

Lastly, there is the potential of incorporating mobile screening units and tele-radiology services as part of the municipal cancer control policies to increase access in the peripheral districts. A multi-level system of policy change, incorporateation of technology, and involvement of communities is likely to produce sustainable solutions to early detection and minimize advanced-stage burden within the area.

7. Conclusion

The effectiveness and the timeliness of early detection systems are key determinants of breast cancer outcomes. In spite of the fact that the global incidence keeps growing, mortality has been reduced, mainly in environments where there are organized population-based screening and effective diagnostic pathways. In LMICs in which incidence is increasing like in Colombia, coupled with structural obstacles that remain unchanged, late-stage presentation is disproportionate, and slow survival gains. The data have shown that screening disruptions and long periods of diagnosis have always led to migrating stages, escalated intensity of treatment and mortality respectively. Institutional patterns in the region of Barranquilla and the Caribbean, as a whole, imply that screening uptake and administrative delays are decreasing, and that the changes in diagnosis are moving towards symptomatic and advanced disease. These trends cause not only clinical outcome worsening but also challenges oncology services and economic pressure in both health systems and households. To eliminate this challenge, the multi-level approach, which

incorporates systematic screening, simplified authorization procedures, specific targeting at vulnerable groups, and advanced surveillance tools, should be adopted. The cost of early detection is in itself economically viable and clinically effective. The burden of advanced breast cancer will keep growing without the fortification of screening infrastructure and minimization of the systemic delays, which will undermine the gains in cancer control and equity.

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