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Lost in the Delay: Symptom-to-Diagnosis Delay and Stage at Diagnosis Among Breast Cancer Patients—A Secondary Data-Based Study

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Research Article

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Abstract

Purpose

Early breast cancer diagnosis is key to early treatment and improved outcomes. Delays between symptom onset and diagnosis may allow disease progression. This study assesses symptom-to-diagnosis delay and its association with stage at diagnosis among women with breast cancer at a tertiary centre in India.

Method:

A retrospective, hospital-based study was conducted using secondary data from Hospital-Based Cancer Registry at a Tertiary care centre in Bengaluru, India, covering women diagnosed with breast cancer during 2023, 2024, and 2025. 452 patients met the inclusion criteria. Diagnostic delay was defined as interval, in months, between first symptom recognition and histopathological confirmation of breast cancer at the study centre.

Result:

Among 452 breast cancer patients, median symptom-to-diagnosis delay was 3 months, mean 11.87 months, and 46.6% experienced delay of more than 3 months. A breast lump was the most common symptom in 70.8%. 60.2% were diagnosed at an early stage (stage 1 and stage 2) and 39.8% at a late stage (stage 3 and stage 4). Symptom-to-diagnosis delay was associated with stage ($p < 0.001$). Late-stage diagnosis increased across delay quartiles ($p < 0.001$), from 14.9% in the lowest quartile to 65.2% in the highest. On multivariable logistic regression, symptom duration ($p < 0.001$) and breast lump with axillary involvement ($p < 0.001$) predicted the risk of late-stage diagnosis.

Conclusion:

The majority of patients experienced prolonged symptom-to-diagnosis delays that were associated with higher disease stages at diagnosis. This study underscores the need for grassroots community programs emphasizing early detection and breast cancer awareness.

Introduction

Breast cancer remains the most common cancer among women worldwide, with an estimated 670,000 deaths and 2.4 million new diagnoses in 2024[1] and it is the most prevalent cancer among Indian women, accounting for approximately 216,108 cases in 2022 within a national cancer burden projected to reach 1.57 million cases by 2025 [2]. Despite progress in cancer survival, international differences remain wide, with 5-year breast cancer survival as low as 66.1% in India compared with 90.2% in the USA. This gap reflects the need for care, early detection, and access to treatment in low- and middle-income countries [3]. Early detection remains the most effective strategy for improving survival. While organized screening programs are established in high-income countries, structured breast self-examination and community-based awareness programs offer a more feasible approach in resource-limited settings when implemented systematically[4] [5]. In a community-based study conducted in a low- and middle-income country (LMIC), approximately 10% of participants reported having undergone screening or clinical examinations. Furthermore, nearly half of the population lacked awareness of breast cancer symptoms and held the belief that breast cancer is incurable, thereby underscoring significant misconceptions about the disease[4]. A painless lump in the breast is the most prevalent initial symptom reported [6]. Detecting such lumps through breast self-examination can aid in the earlier identification of breast abnormalities and promote prompt clinical evaluation.

Patient delay plays a crucial role in advanced-stage diagnosis: on average, a 15-month gap separates symptom recognition from the decision to seek consultation, and this prolonged interval has been linked to reduced treatment effectiveness and poorer prognosis [7]. This prolonged interval has been associated with reduced effectiveness of treatment options and poorer prognosis in previous studies. Understanding the underlying reasons for such delays is vital to developing strategies that encourage timely medical intervention and improve patient outcomes. Socioeconomic barriers partly explain the

differences between high-income and low-income countries. The evidence from previous studies suggests that there are multifactorial causes for delays, such as patient-related factors including poor awareness, misinterpretation of early symptoms as benign diseases, fear of diagnosis, stigma, denial, reliance on traditional or alternative therapies, and social factors such as place of living, financial problem and limited social support. Health system barriers are also a major cause in LMICs, including a lack of infrastructure, poor access to primary care, and a shortage of trained professionals [8–10].

A population-based study identified a correlation between the type of presenting symptom and the stage at diagnosis across various cancer types, including breast cancer [11]. In cases of breast cancer, the presence of a breast lump alone did not exhibit a strong association with advanced-stage disease, in contrast to a lump accompanied by additional symptoms. A large multicentre Indian registry study identified tumor-related factors such as tumor size and grade and health-system factors such as hospital type and level of care as key predictors of metastatic presentation [12]. However, these predictors are only available after diagnosis, whereas symptom duration and presenting symptom category are available at first clinical contact, potentially enabling earlier prediction of late-stage disease and faster referral.

This study aims to assess the diagnosis delay and the time interval between the first recognition of breast cancer symptoms and diagnosis confirmation of breast cancer at the study centre. It further seeks to examine whether diagnostic delay is associated with the stage of breast cancer at diagnosis and, as an exploratory secondary aim, to develop a preliminary risk-prediction model for the risk of late-stage disease based on symptom-to-diagnosis delay and presenting symptom category.

Methods and Materials

The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to ensure transparency and credibility.

Study Design and Settings

A retrospective hospital-based study was conducted from September 2025 to August 2026 at a Tertiary care hospital, which serves patients from Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, other states, and international patients. The center has maintained a hospital-based cancer registry under the National Cancer Registry Programme (ICMR-NINE) since September 2010, reporting cancer cases to the Government of India for 16 years.

Study participants

This study did not involve human participation; it used medical records of breast cancer patients diagnosed and registered in 2023, 2024, and 2025 per study parameters. Eligible patients were assessed using predefined inclusion and exclusion criteria. Data collection followed registry approval, and confidentiality was maintained by anonymizing personal identifiers before analysis.

Inclusion criteria

- Female patients aged 18 years and above who were newly diagnosed with breast cancer at the study centre between January 2023 and December 2025.
- Records containing the date of initial symptom recognition, initial and presenting symptoms, sociodemographic data, date of diagnosis, date of first consultation, staging, and other clinical records.

Exclusion criteria

- Patients with breast cancer recurrence.
- Patients with incomplete medical records.

- Patients diagnosed with breast cancer at other hospitals and presenting to the study centre solely for follow-up care.

Defining Patient Delay

In this study, diagnosis delay was defined as the interval, in months, between first symptom recognition and histopathological confirmation of breast cancer at the study centre. As this was a retrospective record-review study, visits to other providers prior to presentation were not consistently documented and could not reliably be separated out; delay was therefore calculated from symptom recognition to confirmation at the study centre, consistent with prior methods [13]. A delay of more than three months, a threshold established in several studies conducted in low- and middle-income countries and initially proposed in 1938, was employed to define delayed presentation. This duration has been associated to more advanced disease stages and decreased survival rates[14–19] .

Data Retrieval and Collection

After permission from the registry in-charge, two researchers (SKM, RSR) extracted data for 529 female breast cancer patients registered across 2023–2025, with verification by three others (ST, NK, VLV). Extraction used two independent, blind roles-one recording symptom duration and the other recording diagnosis date and presenting symptoms, to minimize outcome-related bias, with data updated weekly under patient-ID-only identification. Double screening (threshold of 10 patients) cross-checked discharge summaries, clinical, pathology, and nursing notes. Of 529 patients, 77 were excluded (14 recurrent, 29 diagnosed elsewhere, 34 incomplete), leaving 452 eligible records.

Variables

The dependent variable was stage at breast cancer diagnosis. The stage at diagnosis was dichotomized into early stage (I–II) and late stage (III–IV), which was consistent with the classification used in previous breast cancer delay studies [20]. Two independent variables were examined separately: (1) diagnostic delay, a continuous variable measured in months as the interval between symptom recognition and diagnostic confirmation; and (2) presenting symptom category, a nominal variable with seven groups (breast lump only, breast lump with pain, nipple symptoms, axillary symptoms, skin changes/ulceration, constitutional symptoms, and other symptoms), using breast lump only as the reference category. The presenting symptom categories were derived empirically from the observed dataset. The symptom-to-diagnosis interval was categorized as < 1 month, 1–3 months, > 3–6 months, and > 6 months, based on published classifications of breast cancer diagnostic delay[21].

Data Sources, Measurement, and Bias

Data were obtained from the registry and electronic medical records and entered structured Excel and Google Sheets databases using unique patient identifiers. Stage was classified using the AJCC 9th Edition TNM staging system [22]. Collected variables included demographic and clinical characteristics. Because the study relied on secondary data, recall bias affecting recorded symptom-onset dates was possible, in addition to selection bias from excluding incomplete records; both were minimized through dual screening and independent verification by three researchers.

Sample size

The sample size was estimated using Cochran's formula based on a reported delayed-presentation prevalence of 57.81% from a mixed-methods study in central rural India. [23] At 95% confidence and a 5% margin of error, the minimum required sample was 375, revised to 420 after 10% inflation for incomplete records (OpenEpi v3). The final analysed sample of 452 records exceeded this requirement.

Quantitative variables

Age and diagnostic delay were treated as continuous variables and also grouped for description (age by decade; delay as < 1, 1–3, > 3–6, > 6 months) to examine their association with stage, which was recorded using the AJCC-TNM system [22] and dichotomized into early (I–II) and late (III–IV) stage for analysis.

Data analysis: Data were analyzed in jamovi (Version 2.6, 2025). Categorical variables were summarized as frequencies and percentages, and continuous variables as mean ± SD or median (IQR) given the non-normal distribution of delay. Mann–Whitney U compared delay between early- and late-stage groups, Kruskal–Wallis compared delay across eight stage categories, and chi-square assessed associations between delay groups and stage. Binary logistic regression identified predictors of late-stage disease (coded 1 for stage 3–4, 0 for stage 1–2), with delay and symptom category (lump alone as reference) as predictors, reported as odds ratios with 95% CI. Model fit was assessed using McFadden's pseudo-R^2, AIC, and deviance, and discrimination using AUC. Delay was additionally grouped into quartiles (Q1: 0.1–2.0; Q2: 2.5–3.0; Q3: 3.5–7.0; Q4: 8.0–420.0 months) to examine late-stage proportions across quartiles.

Result:

The study enrolled 452 breast cancer patients, with a mean age of 54.2 ± 12.6 years. Most were aged 41–50 (n = 122, 27%), 51–60 (n = 120, 26.5%), and 61–70 (n = 93, 20.6%), whereas few were aged 91–100 (n = 1, 0.1%), 21–30 (n = 4, 0.9%), and 81–90 (n = 13, 2.9%). Most resided in urban areas (n = 331, 73.2%), while 26.8% (n = 121) lived in rural settings. Right-side breast cancer was more prevalent (n = 256, 54.4%) than left-side breast cancer (n = 206, 45.6%). The most common stage at presentation was stage 2B (n = 114, 25.2%), followed by stage 2A (n = 98, 21.7%), stage 4 (n = 76, 16.8%), stage 3A (n = 49, 10.8%), stage 3B (n = 42, 9.3%), and stage 3C (n = 13, 2.9%); stage 1A and stage 1B occurred in 13.3% (n = 60). Overall, 56.7% presented with late-stage disease (stage 3 and stage 4) (Table 1). Among 37 initial symptoms recorded across 452 patients, breast lump was most common (n = 329, 70.8%), followed by breast lump with pain, breast lump with pricking-type pain, breast pain alone, and bloody nipple discharge. Less common symptoms included breast swelling and axillary-region involvement with breast lumps. Other symptoms were uncommon, and the remainder each accounted for < 1.0% of cases (Table 2).

Table 1
Sociodemographic and Clinical Characteristics of Women Diagnosed with Breast Cancer (N = 452)

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Legend:		
Baseline sociodemographic, clinical, tumor-related, and comorbidity characteristics of women diagnosed with breast cancer (N = 452). Data are presented as frequency (n) and percentage (%) for categorical variables and as mean ± standard deviation (SD) for continuous variables. Sociodemographic characteristics included age, geographic area of residence, and state of origin. Clinical and tumor-related characteristics included laterality, stage at diagnosis, and tumor morphology. Comorbidity status was categorized according to the presence or absence of documented medical conditions.		

Table 2

Distribution of Initial Symptoms and Presenting Symptoms at First Visit to the Study Centre (N = 452) Legend: Initial symptoms represent the first symptom(s) noticed and reported by the patient at the onset of illness. Presenting symptoms represent the symptom categories recorded at the time of presentation to the study centre.

Initial Symptoms (n = 452)	Count of Initial Symptom
breast lump	320 (70.8%)
breast lump and pain	23 (5.1%)
breast lump and pricking type pain	18 (4.0%)
breast pain	15 (3.3%)
bloody nipple discharge	14 (3.1%)
breast swelling	10 (2.2%)
lump in breast and axillary region	7 (1.5%)
breast lump and axillary swelling	5 (1.1%)
breast lump and bloody nipple discharge	4 (0.9%)
breast lump and weight loss	3 (0.7%)
nipple retraction	3 (0.7%)
swelling in the axilla	3 (0.7%)
breast lump and retraction of nipple	2 (0.4%)
breast lump and skin puckering	2 (0.4%)
breast heaviness	1 (0.2%)
breast lump and dull aching pain	1 (0.2%)
breast lump and hip pain	1 (0.2%)
breast lump and lower back ache	1 (0.2%)
breast lump and nipple discharge on and off	1 (0.2%)
breast lump and oily nipple discharge	1 (0.2%)
breast lump and rashes	1 (0.2%)
breast lump, redness, and body pain	1 (0.2%)
breast lump and swelling	1 (0.2%)
breast lump, nipple rashes	1 (0.2%)
breast lump, pain, nipple retraction, and dimpling	1 (0.2%)
breast pain and back pain	1 (0.2%)
burning sensation and breast pain on and off	1 (0.2%)
chest wall pain	1 (0.2%)
left chest swelling and pain	1 (0.2%)
Neck and Shoulder pain	1 (0.2%)

Footnote: Both initial symptom and presenting symptom data are presented as frequency (n) and percentage (%).

Initial Symptoms (n = 452)	Count of Initial Symptom
nipple inversion	1 (0.2%)
nipple inversion and dimpling	1 (0.2%)
nipple itching	1 (0.2%)
redness	1 (0.2%)
right nipple retraction	1 (0.2%)
swelling over chest wall	1 (0.2%)
ulcer in nipple	1 (0.2%)
Presenting Symptom (n = 452)	
Symptoms	n (%)
Breast Lump Only	227 (50.2%)
Breast Lump + Pain	78 (17.3%)
Breast Lump + Nipple Symptoms	23 (5.1%)
Breast Lump + Axillary Symptoms	77 (17.0%)
Breast Lump + Skin Changes/Ulceration	13 (2.9%)
Breast Lump + Constitutional Symptoms	9 (2.0%)
Other Symptoms	25 (5.5%)
Footnote: Both initial symptom and presenting symptom data are presented as frequency (n) and percentage (%).	

Invasive ductal carcinoma was the most common histological subtype, accounting for 93.8% of cases (n = 424). Invasive lobular carcinoma was identified in 1.8% (n = 8), followed by metaplastic carcinoma and malignant phyllodes tumor, each comprising 1.1% (n = 5). Remaining cases included mucinous carcinoma, infiltrating carcinoma, adenocarcinoma, mucinous adenocarcinoma, and squamous cell carcinoma. Patients were from multiple states across India, with few international patients. Most were from Karnataka (n = 278, 61.5%), followed by Tamil Nadu (n = 73, 16.2%), West Bengal (n = 37, 8.2%), and Andhra Pradesh (n = 34, 7.5%). International patients were from Bangladesh (n = 10, 2.2%), Yemen (n = 4, 0.9%), and the United Arab Emirates (n = 1, 0.2%). Hypertension was the most prevalent comorbidity (n = 93, 20.6%), followed by diabetes mellitus (n = 40, 8.8%) and hypothyroidism (n = 24, 5.3%). Less frequent comorbidities included anaemia, asthma/bronchial asthma, ischemic heart disease, and dyslipidaemia. Rare conditions such as hepatitis B, chronic kidney disease, mental retardation, and cerebrovascular accident were each reported in two or fewer patients. Overall, 40.3% of patients (n = 182) had at least one comorbid condition, whereas 59.7% (n = 270) had no documented comorbidity (Table 1). Presenting symptoms were categorized based on symptoms at admission. The most common was breast lump only (n = 227, 50.2%), followed by breast lump and pain (n = 78, 17.3%), breast lump with axillary symptoms (n = 77, 17.0%), breast lump with nipple symptoms (n = 23, 5.1%), breast lump with skin changes or ulceration (n = 13, 2.9%), breast lump with constitutional symptoms (n = 9, 2.9%), and other symptoms (n = 25, 5.5%).

Impact of Patient Delay on Stage at Diagnosis

Among 452 breast cancer patients, the median symptom-to-diagnosis delay was 3 months, the mean was 11.87 months, and the range was 0.1–420 months. Delay increased significantly with later stage ($p < 0.001$). Patients diagnosed at stage 1A/1B had the shortest mean delay, 1.5 months, whereas stage 4 had the longest, with a median of 8.5 months (IQR: 4.0–12.8), over five times that of early stage. Mean delay was 2 months at stage 2A, 3 months at stage 2B, 4 months at stages 3A/3B, and 6 months at stage 3C (Table 3). Among 452 patients, 272 (60.2%) had early-stage disease (stage 1–2) and 180 (39.8%) had

late-stage disease (stage 3–4). Longer delays were significantly associated with late-stage diagnosis ($p < 0.001$). Among patients diagnosed within one month of symptom onset, 85.2% (n = 52) had early-stage disease and 14.8% (n = 9) had late-stage disease. Late-stage diagnoses rose with delay, from 25% (n = 180) at 1–3 months to 52.7% (n = 48) at > 3–6 months and 65% (n = 78) at > 6 months. Early-stage diagnoses declined from 75.0% (n = 135) to 47.3% (n = 43) and 35% (n = 42), respectively (Table 4). A further direct comparison between early- and late-stage patients was then followed by dose-response analysis across delay quartiles. Late-stage patients had a longer median diagnosis delay than early-stage patients: 6 months (IQR: 3.0–12.0) versus 2 months (IQR: 1.0–4.25), a significant difference (Mann-Whitney U = 12,633; $p < 0.001$), with $r = 0.484$. Mean delay was also higher in the late-stage group, 20.35 ± 51.23 months versus 6.28 ± 27.79 months. Spearman correlation confirmed a significant positive association between delay and advancing stage ($p < 0.001$). Dose-response analysis showed late-stage diagnosis increasing across quartiles from 14.9% in the lowest quartile (0.1–2.0 months) to 39.7% in Q2, 53.5% in Q3, and 65.2% in the highest quartile (8.0–420.0 months) (Table 4).

Table 3

Symptom-to-Diagnosis Delay by Stage at Diagnosis and Prevalence of Symptom-to-Diagnosis Delay Greater Than 3 Months Among Women with Breast Cancer (N = 452) Legend: Symptom-to-diagnosis delay was defined as the time interval (in months) between first recognition of symptoms by the patient and diagnosis. Delay duration by stage at diagnosis is presented as median, interquartile range (IQR; Q1–Q3), and range (minimum–maximum), with the overall difference assessed using the Kruskal–Wallis test. Overall delay characteristics and the distribution of delay categories are also presented, including the proportion of women with symptom-to-diagnosis delay greater than 3 months.

Symptom-to-Diagnosis Delay (months) by Stage at Diagnosis							
Stage	**N**	**Median**	**IQR (Q1–Q3)**	**Range**	**p-value**	**Overall delay**	452
1A	38	1.5	0.6–3.8	0.2–24.0		Mean delay (months)	**11.9**
1B	22	1.5	0.7–3.0	0.2–36.0		Median delay (months)	**3**
2A	98	2	1.0–4.0	0.2–240.0		Minimum	**0.1**
2B	114	3	1.0–6.0	0.1–120.0		Maximum	**420**
3A	49	4	3.0–7.0	0.3–288.0			
3B	42	4	3.0–12.0	1.0–288.0			
3C	13	6	3.0–12.0	1.0–240.0			
4	76	8.5	4.0–12.8	0.3–420.0			
Overall	452	3	2.0–7.0	0.1–420.0	**< 0.001**		
Prevalence of Symptom-to-Diagnosis Delay Greater Than 3 Months							
Statistic	**months**	**Delay category**	**Frequency (n)**	**Percentage (%)**			
N	452	< 1 month	61	13.5			
Median	3	1–3 months	180	39.8			
Q1 (25th percentile)	2	3–6 months	91	**20.1**			
Q3 (75th percentile)	7	> 6 months	120	**26.5**			
Interquartile range (IQR)	5	**Total**	**452**	**100**			

Footnote: Data are presented as frequency (n), percentage (%), median, quartiles, IQR, range, or mean ± SD, as appropriate. The prevalence of symptom-to-diagnosis delay greater than 3 months was calculated by combining the 3–6-month and > 6-month categories (211/452, 46.6%). Differences in delay duration across stages at diagnosis were assessed using the Kruskal–Wallis test. IQR = interquartile range; Q1 = first quartile; Q3 = third quartile; SD = standard deviation.

Prevalence of Diagnosis Delay

In the study, 39.8% patients sought diagnosis within 1 to 3 months from symptom onset, while 20.1% had delays of 3 to 6 months and 26.5% for more than 6 months. Overall, 46.6% (211 out of 452) experienced symptom-to-diagnosis delays exceeding 3 months (Table 3).

Multivariable logistic regression analysis of risk predictors of late-stage breast cancer at diagnosis

On univariable analysis, age, residence (urban vs. rural), and comorbidities were not significant predictors of stage (p = 0.829, 0.098, and 0.084, respectively). On multivariable logistic regression, symptom duration and presenting symptom category

independently predicted late-stage diagnosis: each additional month of delay increased the odds of late-stage disease (AOR 1.018; 95% CI 1.004–1.032; p < 0.001). Compared with breast lump alone, odds were highest for lump with axillary symptoms (AOR 5.928; 95% CI 2.351–14.944; p < 0.001), followed by skin changes/ulceration (AOR 4.990; p = 0.002), constitutional symptoms (AOR 4.376), nipple symptoms (AOR 3.618; p = 0.001), and pain (AOR 1.716; p = 0.036); other symptoms were not significant (p = 0.643). The model showed acceptable discrimination (AUC 0.726; 66.4% accuracy; 35.0% sensitivity at 0.5 cutoff), supporting a four-tier risk classification (low < 30%, moderate 30–50%, high 50–70%, very high > 70% probability of late-stage disease) intended to guide targeted counselling, timely referral, and prompt histopathological confirmation (Table 5) (Fig. 1) (Fig. 2).

Prediction Model Equation, Risk Categories, and Illustrative Clinical Example

Logit [P (High Risk Late Stage)] = $\beta_0 + \beta_1 \times$ (Symptom Duration) + $\beta_2..\beta_7 \times$ (Presenting Symptom Category Indicators)

Logit[P(High Risk Late Stage)] = − 1.0123

+ 0.0176 × Duration of Symptom (months)

+ 0.5398 × I(Breast Lump + Pain)

+ 1.2860 × I(Breast Lump + Nipple Symptoms)

+ 1.7796 × I(Breast Lump + Axillary Involvement)

+ 1.6075 × I(Breast Lump + Skin Changes / Ulceration)

+ 1.4762 × I(Breast Lump + Constitutional Symptoms)

+ 0.1997 × I(Other Symptoms)

P (High Risk Late Stage) = 1 / (1 + exp (− Logit [P (High Risk Late Stage)]))

Where:

- I(category) = 1 if the patient presents with that symptom category, 0 otherwise.
- Breast lump alone is the reference category (all indicators = 0).
- Duration = longest duration of symptom in months before seeking medical care
- P (High Risk Late Stage) = predicted probability of presenting at Stage 3 or 4 at diagnosis

< 30% - LOW RISK; 30–50% - MODERATE RISK; 50–70% - HIGH RISK; >70% - VERY HIGH RISK

Example:

Patient with 24-month symptom duration, breast lump + axillary involvement.

Logit = − 1.0123 + (0.0176 × 24) + 1.7796

Logit = − 1.0123 + 0.4224 + 1.7796 = 1.1897

P (High Risk Late Stage) = 1 / (1 + $e^{-1.1897}$) = 76.6% - VERY HIGH RISK

Incidental Finding

Although incidental, the authors wish to disclose this finding. During data collection, four patients with stage 4 breast cancer had a symptom-to-diagnosis delay of 10 to 12 days. Medical records documented that "the lump is not palpable" and "lump

within 10 days." Substantial breast tissue can obscure detection until symptoms manifest or the tumor becomes palpable. In such cases, tumors are identified through medical imaging despite attention, yet patients present with advanced-stage cancer; these are classified as “early presentations but late stage”. Lumps may remain undetected for months, particularly in low- and middle-income countries where health check-ups are unaffordable, raising questions about responsibility for late-stage diagnosis.

Discussion

Our findings indicate an association between symptom-to-diagnosis delay and stage at diagnosis. Longer delay is associated with stage 4 disease, exceeding that in patients diagnosed earlier by more than fivefold. This significant disparity highlights the influence that prompt medical assessment can exert on the progression of a disease. Minimizing time from symptom onset to presentation may improve prognosis and survival in breast cancer patients [24]. This is consistent with LMIC and Indian studies reporting that longer diagnostic delay is associated with later-stage presentation [7, 25–27]. The mean patient age (53.9 ± 12.9 years) was somewhat higher than reported in Bangladesh (46.8), Ethiopia (43.4), and China (52.4), but close to a systematic review of high- and middle-income countries (57 years) [28–31]. The urban predominance in our cohort likely reflects the metropolitan location of the study centre. Previous studies have identified a correlation between delayed breast cancer presentation and rural residence [32, 33]. A breast lump was the most common initial and presenting symptom, consistent with prior reports [34]. though a lump may also indicate benign disease such as fibroadenoma [35, 36]. Accurate documentation and monitoring of such symptoms in primary care is essential for timely referral to specialized providers.

The average symptom-to-diagnosis delay in this cohort is 11.87 months is longer than reported in Bangladesh (5.18), Ethiopia (8), and Ghana (9 months) and a systematic review from Africa (6 months) [7, 28, 29, 37, 38]. The delay experienced by our patient cohort aligns, to some extent, with findings from a study conducted in Delhi, India, which documented a delay of 10.90 months [6]. However, in developing countries, the delay in breast cancer diagnosis is greater compared to developed countries [25, 39]. Patient-level barriers, including low awareness, rural residence, and low socioeconomic status, alongside health system-level factors such as limited access to tertiary care, are notably pronounced in low- and middle-income countries [40]. The study demonstrated that the symptom-to-diagnosis delay was significantly associated with the stage at diagnosis, with longer delays correlating with later-stage diagnosis. This finding highlights the critical impact of diagnostic timing on disease progression. Early detection may reduce the delay and improve patient outcomes by enabling treatment at an earlier stage. Therefore, strategies to minimize diagnostic delays should be prioritized in clinical practice. Our study aligns with previous research indicating that extended delays in the presentation of breast cancer are associated with diagnoses at more advanced stages [26, 27, 41]. Considering these delays, it is also essential to identify the initial symptoms experienced by breast cancer patients. Often, individuals in typical households with minimal health literacy might fail to recognize and ignore the first or occasional symptoms. However, recognizing the first symptom and reporting it immediately to specialized healthcare providers is critically important for early diagnosis and improved outcomes. Reported patient-level barriers to timely presentation include sociocultural and economic factors, psychological issues, limited health literacy, restricted decision-making authority, and logistical difficulties[42–44]. While Indian studies additionally report referral delays, distance to care, financial constraints, workforce shortages, and inadequate follow-up as systemic barriers [45, 46]. Addressing referral pathways, expanding primary-care access closer to patients’ homes, and strengthening follow-up and financial support are therefore critical steps.

Our study developed a predictive model to assess risk associated with late-stage breast cancer presentation. The primary predictors were delay duration and presenting symptoms. In primary health care hospitals, clinics, or initial assessments by health care providers, including clinical breast examinations and primary screening scans, this model can identify patients at risk. If malignancy is suspected, it can expedite referral and counsel patients toward prompt biopsy and diagnosis, reducing burden. Similar studies using random forest, neural networks, and logistic regression in Iran identified key predictors of diagnostic delay, demonstrating computational feasibility [47]. Another study indicated that the presence of breast symptoms other than a lump independently predicted delays at the provider level. This finding confirms that the type of symptom is a clinically significant predictor [48], and should be integrated into risk stratification tools. Furthermore, a study from Zimbabwe

confirmed that primary delay was independently predictive of advanced-stage disease at diagnosis using logistic regression, with longer delay times and larger tumour size among the significantly associated factors [49]. Our model, which achieved acceptable discrimination (AUC 0.726), is a predictive rather than diagnostic tool; its reliance on secondary data, without tumour size or imaging findings, is an important limitation. Nonetheless, because symptom duration and category are available at first contact, this approach could support earlier risk stratification in LMIC settings where delayed diagnosis remains prevalent.

Strengths and limitations of this study

A major strength of this study was the demonstration of a significant association between symptom-to-diagnosis delay and advanced stage at breast cancer diagnosis, highlighting gaps between symptom recognition and timely specialised care. The study also developed a risk prediction model to identify patients at higher risk of late-stage diagnosis based on symptom duration and presenting symptoms. However, the retrospective, single-centre design relied on medical records and may be affected by incomplete documentation and recall bias regarding symptom onset, limiting generalisability to other populations and healthcare settings. Future qualitative research is warranted to explore patients' perceptions, health-seeking decisions, and barriers contributing to diagnostic delay.

Conclusion and Suggestions

This study highlights the need for structured, community-level breast cancer awareness programs, including tools such as a breast self-examination logbook to encourage monthly self-examination. Strengthening primary healthcare access and referral pathways for symptomatic patients is essential to reduce diagnostic delay, particularly in resource-limited settings. A substantial proportion of patients experienced symptom-to-diagnosis delay, which was significantly associated with higher stage at diagnosis; misinterpretation of a painless lump as non-serious, leading to denial of severity, may partly explain this delay. Addressing these multifactorial determinants including through standardized symptom documentation across healthcare levels could help identify at-risk patients earlier and shorten diagnostic pathways

Declarations

Competing Interests

No conflict of interest was declared by the author(s) concerning this research, authorship, or publication.

Author Contribution

SKM: Conceptualisation, data collection, formal analysis, and manuscript drafting. RSR: Study supervision, data collection design, and critical review. NANK: Supervision and critical review. VLV: Data management, data checking. ST: Conceptualisation, supervision, critical revision, data checking and final approval of the manuscript for submission. All authors approved the final manuscript.

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Data availability statement:

Raw data are not publicly available due to patient confidentiality. De-identified data may be made available upon reasonable request to the corresponding author.

Patient consent for publication

Not applicable.

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Figures

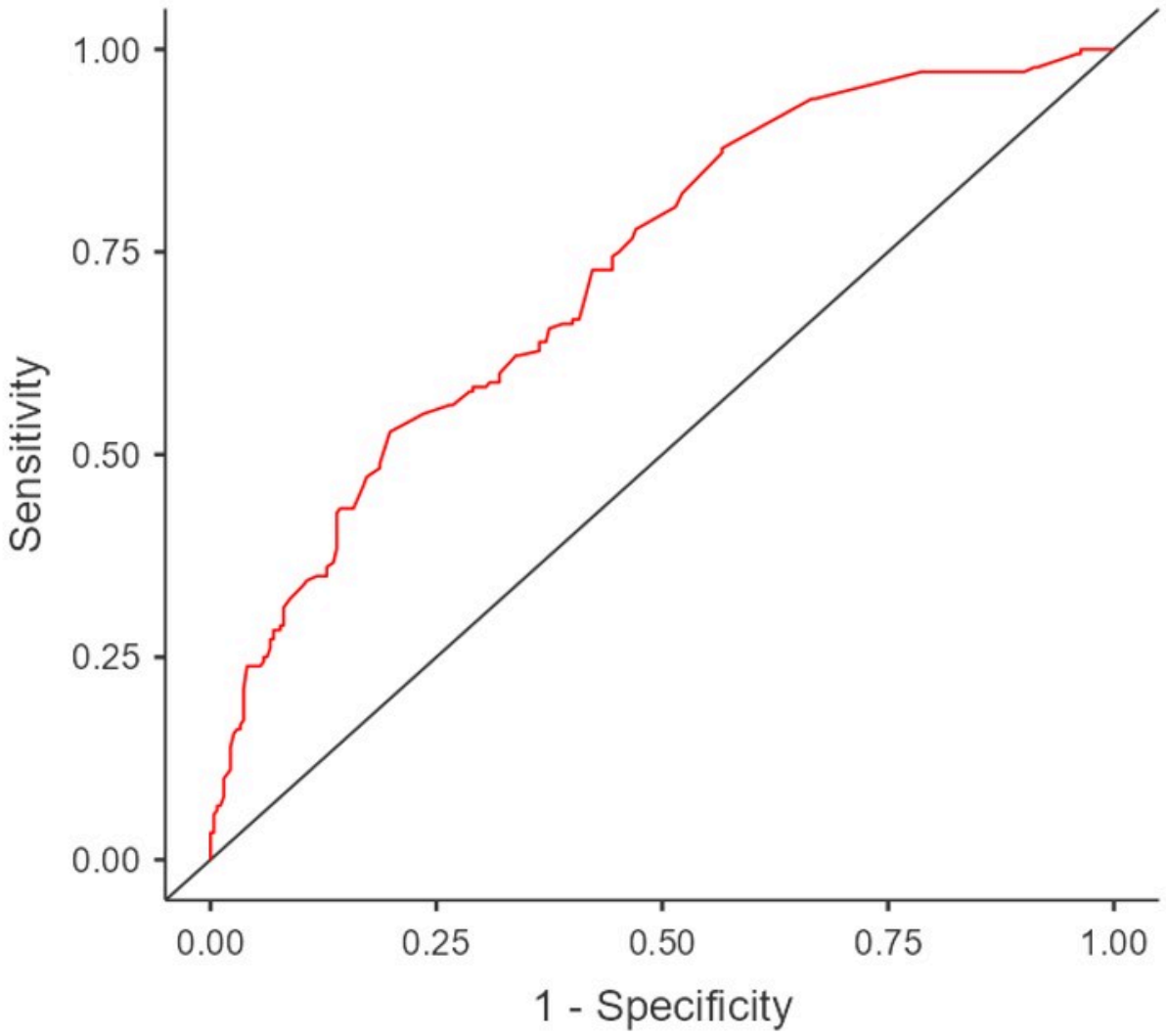


Figure 1

Receiver Operating Characteristic (ROC) Curve of the Prediction Model for Late-Stage (Stage III–IV) Breast Cancer at Diagnosis

Legend:

ROC curve of the final logistic regression model predicting late-stage breast cancer diagnosis. A diagonal reference line represents chance classification.

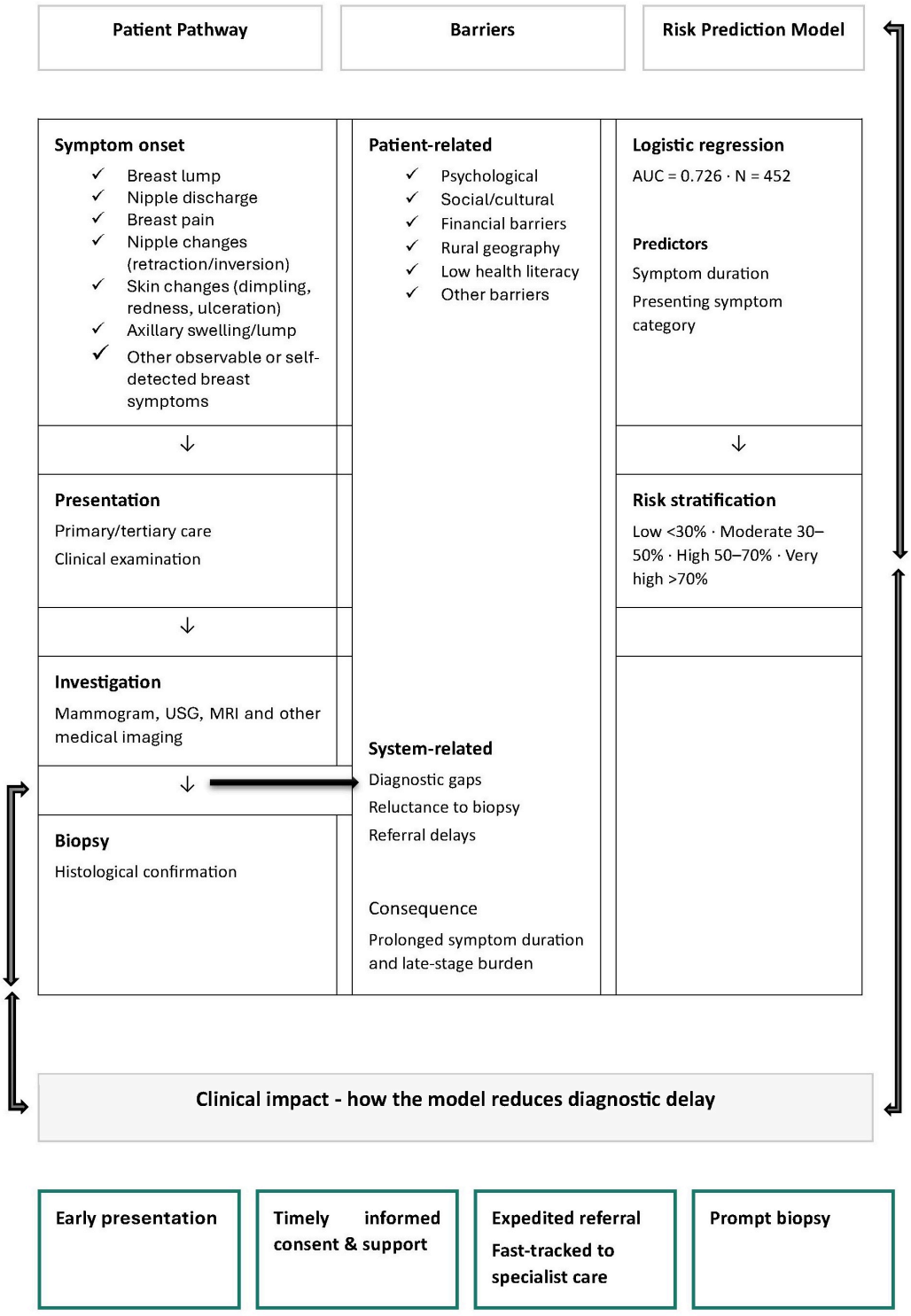


Figure 2

Conceptual pathway from breast symptom onset to late-stage diagnosis and the role of the risk prediction model.

Footnote: Conceptual pathway illustrating the potential application of the risk prediction model. Patient-related and system-related barriers may contribute to prolonged symptom duration, delayed biopsy, and late-stage presentation. The logistic regression model (AUC = 0.726; N = 452), based on symptom duration and presenting symptom category, stratifies patients according to their risk of late-stage disease. Identification of high-risk individuals may facilitate targeted counselling, timely

informed consent, expedited referral, and prompt histopathological confirmation, thereby reduce patient- and system-level diagnostic delays and promoting earlier diagnosis and treatment.