The Breast 83 (2025) 104556

Contents lists available at ScienceDirect

The Breast

journal homepage: www.journals.elsevier.com/the-breast

Long-term survival outcomes of male breast cancer: the propensity score matching analysis of nationwide registry database

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ARTICLE INFO

Keywords:
Male breast cancer
Mortality
Prognosis
Trend

ABSTRACT

Background: s: Few studies have examined the prognosis of male breast cancer patients in Western countries. However, data on the long-term outcomes in Asian male patients are limited. Thus, we aimed to compare long-term survival outcomes between male and female patients including cancer-specific mortality.
Methods: We included male patients diagnosed with primary breast cancer between 1981 and 2014 using nationwide data from the Korean Breast Cancer Registry (KBCR). After propensity score matching with female patients using covariates such as age, year of diagnosis, stage, and hormone receptor status, survival analyses using the Kaplan-Meier method and log-rank test were performed to evaluate breast cancer-specific survival (BCSS) and overall survival (OS).
Results: After matching 680 patients, the median age was 62 years for male patients. Most patients underwent mastectomy, and 35.3 % had stage 1 disease. Ten years after diagnosis, there was no significant difference in the BCSS rates between the sexes. However, the OS rate was lower in males that in females (68.0 % vs. 79.0 %, $p = 0.027$). There was no significant improvement in survival outcomes among male patients in the late diagnostic period (2000–2010) compared to those in the early period (1981–1999).
Conclusion: In this nationwide cohort study, we observed no improvement in survival outcomes among male breast cancer patients diagnosed in the recent years. Despite similar BCSS between sexes, male patients demonstrated significantly worse OS than female patients, likely due to higher non–cancer-related mortality.

1. Background

Breast cancer is one of the most common types of cancer worldwide, affecting both men and women; however, it is much less frequent in men. Breast cancer in men accounts for approximately 1 % of all breast cancers, and its incidence has increased over the recent decades [1,2]. Recent advances in medical technology, which have led to better screening and more effective treatments, have improved the clinical outcomes of female breast cancer [3,4]. However, despite these advances in strategies for early detection and individualized treatment, male breast cancer remains understudied, and there are limited data available on the prognosis and survival outcomes of male patients with breast cancer.

Recently, Leone et al. [5] showed that breast cancer mortality in men has declined significantly over the past three decades using data from the Surveillance, Epidemiology, and End Results (SEER) program, a population-based cancer registry in the United States. However, the long-term survival outcomes of male patients compared with those of female patients remain controversial. Some studies have found no significant differences in survival outcomes between male and female

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https://doi.org/10.1016/j.breast.2025.104556
Received 25 February 2025; Received in revised form 19 May 2025; Accepted 4 August 2025
Available online 6 August 2025

patients [6,7]. However, other studies have suggested that male patients with breast cancer may have worse survival outcomes than female patients despite similar treatment regimens [8,9]. To date, there are still unanswered questions regarding clinical outcomes among male patients due to the lack of clinical data.

Therefore, studying the long-term clinical outcomes of male breast cancer is crucial, particularly in Asian populations, where data on male breast cancer are limited, to improve treatment options and survival rates. This study aimed to investigate the impact of sex and period of diagnosis on survival outcomes in male patients with breast cancer in Asian populations.

2. Methods

2.1. Data source and study design

We used nationwide prospectively maintained data from the Korean Breast Cancer Registry (KBCR), an online registry of the Korean Breast Cancer Society (KBCS) involving more than 100 institutions in South Korea. We assessed the data of men who were diagnosed with invasive breast cancer between 1981 and 2014 and analyzed the following variables: age, year of diagnosis of breast cancer, type of surgery, pathological TNM stage according to the American Joint Committee on Cancer (AJCC) 8th edition staging system, pathological characteristics (tumor size, histological grade, estrogen receptor (ER) status, progesterone receptor (PR) status, human epidermal growth factor receptor 2 (HER2) status), survival outcome, date of death, and cause of death. We defined hormone receptor positivity based on a 1 % cut-off. The patients were categorized into two groups according to the year of diagnosis (1981–1999 and 2000–2010). The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Hanyang University Hospital, Hanyang University, Seoul, Korea (no. HYUH 2024-03-023), and adhered to the principles of the Declaration of Helsinki. Owing to the retrospective study design, the requirement for written informed consent was waived.

2.2. Statistical analysis

To compare survival outcomes between male and female patients, we performed propensity score matching using the nearest neighbor method in a 1:1 ratio. Matching was based on age at surgery, year of diagnosis, surgical method, and other relevant covariates. After matching, the balance between groups was checked using the standardized mean difference (SMD). Baseline characteristics were compared by sex using the chi-square test or Fisher's exact test. Survival curves from diagnosis to the 10-year follow-up were analyzed using the Kaplan-Meier method and the log-rank test to evaluate breast cancer-specific survival (BCSS) and overall survival (OS). Cox proportional hazards regression models were used to determine the effects of sex on BCSS and OS. The survival rates were adjusted for confounders. Hazard ratios (HRs) are presented with 95 % confidence intervals (CIs). Additionally, a sub-analysis of male patients was conducted, dividing them into two groups based on the year of diagnosis (1981–1999 and 2000–2010) to identify differences in baseline characteristics. Survival curve differences and HR for BCSS and OS by year of diagnosis were determined similarly to the analysis by sex. All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, North Carolina, USA), and *p*-values less than 0.05 were considered statistically significant.

3. Results

3.1. Patient characteristics

We collected data on over 100,000 breast cancer patients through the nationwide registry from the Korean Breast Cancer Society

Table 1
Patient characteristics after the propensity score matching (N = 680).

Variables	Male	Female	Total	p	SMD
Number of patients	340 (50.0)	340 (50.0)	680 (100.0)		
Age at surgery				0.995	0.008
<50	72 (21.2)	73 (21.5)	145 (21.3)		
50-64	124 (36.5)	124 (36.5)	248 (36.5)		
>64	144 (42.4)	143 (42.1)	287 (42.2)		
Year of diagnosis				0.834	0.016
1981–2003	55 (16.2)	53 (15.6)	108 (15.9)		
2004–2014	285 (83.8)	287 (84.4)	572 (84.1)		
Surgery				1.000	<0.001
Breast conservation surgery	28 (8.2)	28 (8.2)	56 (8.2)		
Mastectomy	309 (90.9)	309 (90.9)	618 (90.9)		
No surgery	3 (0.9)	3 (0.9)	6 (0.9)		
Others	0 (0.0)	0 (0.0)	0 (0.0)		
Axillary surgery				0.981	0.050
ALND	166 (48.8)	167 (49.1)	333 (49.0)		
SLNB	77 (22.6)	77 (22.6)	154 (22.6)		
SLNB + ALND	71 (20.9)	71 (20.9)	142 (20.9)		
No surgery	25 (7.4)	23 (6.8)	48 (7.1)		
Unknown	1 (0.3)	2 (0.6)	3 (0.4)		
Pathologic tumor stage				0.677	0.136
Tis	17 (5.0)	19 (5.6)	36 (5.3)		
T1	180 (52.9)	170 (50.2)	350 (51.6)		
T2	124 (36.5)	125 (36.9)	249 (36.7)		
T3	9 (2.7)	17 (5.0)	26 (3.8)		
T4	8 (2.4)	6 (1.8)	14 (2.1)		
Unknown	2 (0.6)	2 (0.6)	4 (0.6)		
Pathologic nodal status				0.426	0.151
N0	197 (58.1)	190 (55.9)	387 (57.0)		
N1	90 (26.6)	95 (27.9)	185 (27.3)		
N2	38 (11.2)	31 (9.1)	69 (10.2)		
N3	13 (3.8)	21 (6.2)	34 (5.0)		
Unknown	1 (0.3)	3 (0.9)	4 (0.6)		
Disease stage				1.000	0.018
0	14 (4.1)	15 (4.4)	29 (4.3)		
1	120 (35.3)	121 (35.6)	241 (35.4)		
2	140 (41.2)	138 (40.6)	278 (40.9)		
3	61 (17.9)	61 (17.9)	122 (17.9)		
Unknown	5 (1.5)	5 (1.5)	10 (1.5)		
Histology ductal type				0.909	0.009
Yes	296 (87.1)	297 (87.4)	593 (87.2)		
No	44 (12.9)	43 (12.6)	87 (12.8)		
ER				1.000	0.012
Negative	24 (7.1)	23 (6.8)	47 (6.9)		
Positive	315 (92.6)	316 (92.9)	631 (92.8)		
Unknown	1 (0.3)	1 (0.3)	2 (0.3)		
PR				0.937	0.045
Negative	54 (15.9)	53 (15.6)	107 (15.7)		
Positive	284 (83.5)	286 (84.1)	570 (83.8)		
Unknown	2 (0.6)	1 (0.3)	3 (0.4)		
HER2				0.993	0.009
Negative	256 (75.3)	257 (75.6)	513 (75.4)		
Positive	41 (12.1)	41 (12.1)	82 (12.1)		
Borderline	43 (12.6)	42 (12.4)	85 (12.5)		
Endocrine therapy				<0.001	0.698
SERM	250 (73.5)	166 (48.8)	416 (61.2)		
AI	21 (6.2)	102 (30.0)	123 (18.1)		
Others	22 (6.5)	34 (10.0)	56 (8.2)		
Not done	47 (13.8)	38 (11.2)	85 (12.5)		
Chemotherapy				0.925	0.007
Yes	199 (59.9)	202 (60.3)	401 (60.1)		
No	133 (40.1)	133 (39.7)	266 (39.9)		
Radiotherapy				0.259	0.089
Yes	76 (23.4)	88 (27.2)	164 (25.3)		
No	249 (76.6)	235 (72.8)	484 (74.7)		
Status				–	–
Alive	282 (82.9)	298 (87.6)	580 (85.3)		

(*continued on next page*)

Table 1 (*continued*)

Variables	Male	Female	Total	p	SMD
Dead	58 (17.1)	42 (12.4)	100 (14.7)		
Cause of death				–	–
Alive	282 (82.9)	298 (87.6)	580 (85.3)		
Breast cancer	9 (2.6)	15 (4.4)	24 (3.5)		
Other cause	14 (4.1)	8 (2.4)	22 (3.2)		
Unknown cause	35 (10.3)	19 (5.6)	54 (7.9)		

SMD, standardized mean difference; ALND, axillary lymph node dissection; SLNB, sentinel lymph node biopsy; ER, estrogen receptor; PR, progesterone receptor; HER2, human epidermal growth factor receptor 2.

(Supplementary Table 1). After matching male and female patients with 1:1 ratio, we assessed their demographic and clinical characteristics (Table 1). The age distribution at the time of surgery was similar between groups, with the most significant proportion of patients being 64 years or older. The median age was 62 years for male patients and 58.5 years for female patients. Most patients underwent mastectomy (90.9 %), and the most frequent axillary surgery was axillary lymph node dissection (ALND, 49.0 %), followed by sentinel lymph node biopsy (SLNB, 22.6 %) and SLNB + ALND (20.9 %). The predominant cancer stages were stages 2 (40.9 %) and 1 (35.4 %), with ductal histology being the most prevalent type (87.2 %). Most patients were ER-positive (92.8 %) and PR-positive (83.8 %), and HER2-negative (75.4 %). Of all, 87.5 % of patients received endocrine therapy, 60.1 % had chemotherapy, and 25.3 % had radiotherapy. Survival rates indicated that 82.9 % of male and 87.6 % of female patients were alive, whereas breast cancer-specific deaths occurred in 2.6 % of males and 4.4 % of females. Among non–breast cancer causes of death, the occurrence of second primary malignancies was twice as high in male patients (6 cases) compared to female patients (3 cases). Overall, the variables were similar between the groups, with minimal differences indicated by SMD.

3.2. Survival analysis

The median follow-up was 57.2 months (IQR 30.4–99.0) for males and 63.5 months (IQR 35.0–106.7) for females. Fig. 1 shows the survival curves for BCSS and OS, stratified by sex. At 10 years, the BCSS rates were 94.9 % (95 % CI: 90.9 %–99.2 %) for male patients and 92.8 % (95 % CI: 89.1 %–96.7 %) for female patients, revealing no statistically significant difference between them ($p = 0.321$). In contrast, at 10 years, the OS rates were 68.0 % (95 % CI: 60.6 %–76.3 %) for male patients and 79.0 % (95 % CI: 72.6 %–85.9 %) for female patients ($p = 0.027$). The effects of sex on the BCSS and OS were assessed over a 10-year follow-up period (Table 2). The HR for BCSS comparing male and female patients was 0.66 (95 % CI: 0.29–1.51, $p = 0.324$), indicating no statistically significant difference between them. Conversely, the HR for OS was 1.56 (95 % CI: 1.05–2.33, $p = 0.029$), indicating a significantly higher risk of all-cause mortality in males than females.

3.3. Subgroup analysis

We examined whether there was a difference in survival outcomes between male and female patients based on their ER and HER2 status. The BCSS did not differ between sexes based on ER and HER2 positivity (Figs. 2 and 3). However, there was a significant difference in OS between the sexes for the ER-positive subtypes, with males having a significantly lower OS rate than females ($p = 0.010$). Additionally, there was no significant difference in BCSS based on the cancer stage; however, there was a significant difference in OS between male and female patients with stage 2 disease (Supplementary Figs. 1 and 2).

Furthermore, we investigated whether there were differences between males and females depending on whether they received chemotherapy, radiation therapy, or hormonal therapy (Supplementary Figs. 3–5). Among male patients, those who did not receive radiation therapy had worse overall survival compared to females, whereas those who received endocrine therapy showed better breast cancer-specific survival than female patients ($p = 0.003$, $p = 0.025$, respectively).

3.4. Comparison by diagnosis period

Male patients were categorized into two groups based on the year of

Table 2
Cox regression for breast cancer-specific survival and overall survival after matching.

	Breast cancer-specific survival		Overall survival	
	HR (95 % CI)	p	HR (95 % CI)	p
Male vs. Female	0.66 (0.29–1.51)	0.324	1.56 (1.05–2.33)	0.029

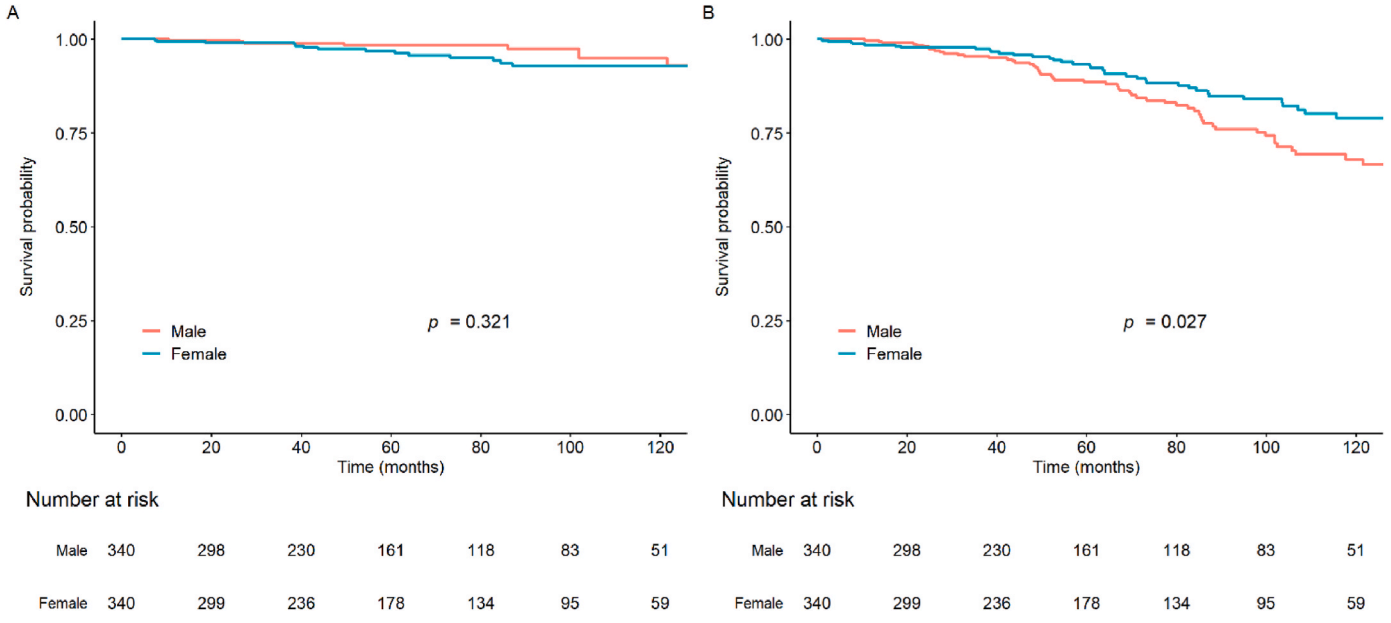

Fig. 1. Kaplan-Meier curve for (A) breast cancer-specific survival and (B) overall survival after matching.

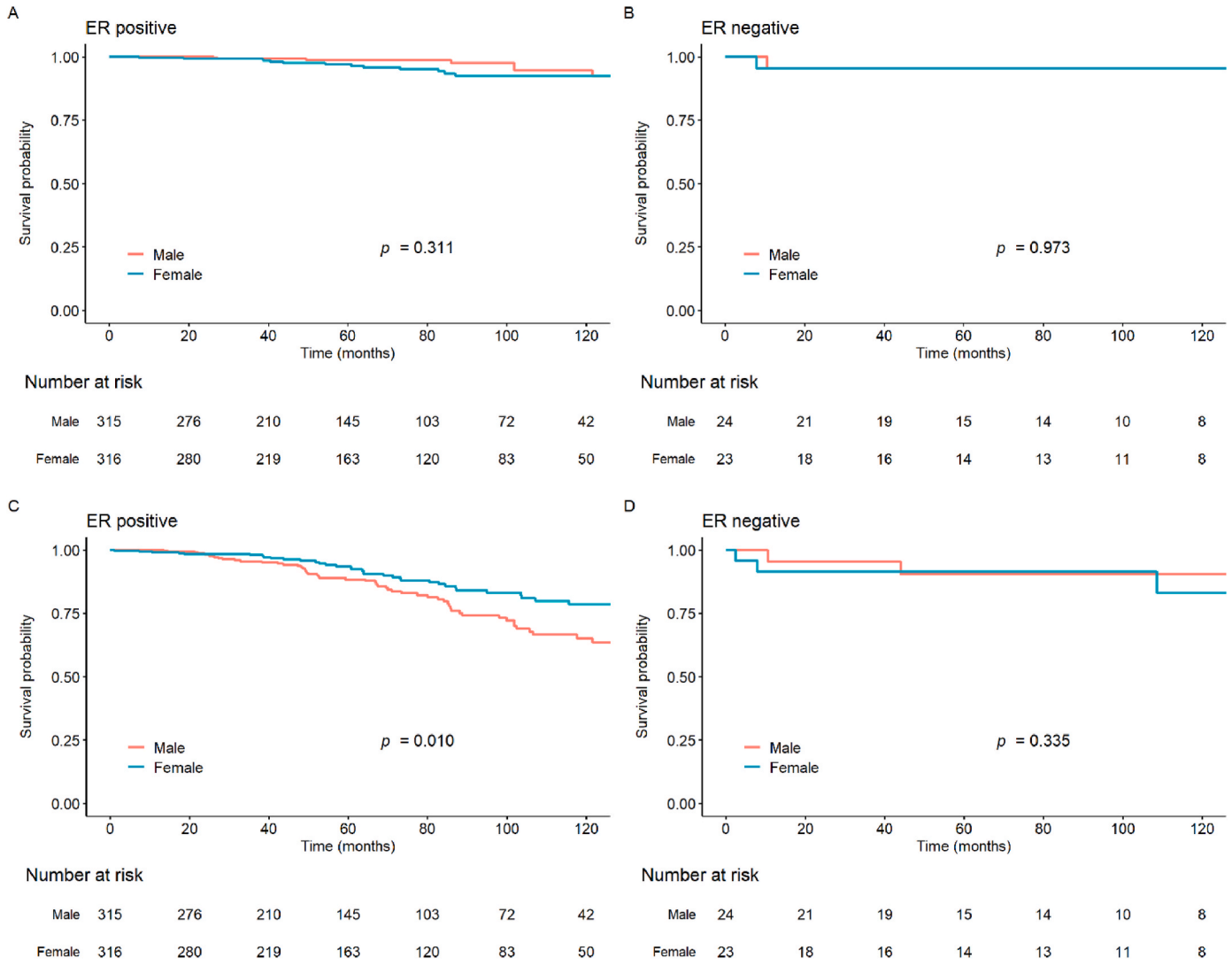

Fig. 2. Kaplan-Meier curve for (A–B) breast cancer-specific survival and (C–D) overall survival by ER status after matching.

diagnosis: early (1981–1999) and late (2000–2010) period. Significant differences between the two periods were observed in terms of surgery, axillary surgery, ER, PR, and HER2 status (Table 3). The proportion of breast conservation surgery patients increased from 3.4 % to 11.1 %, while mastectomy decreased from 92.0 % to 85.2 % ($p = 0.008$). ALND alone decreased from 90.8 % to 57.1 % during axillary surgery, whereas SLNB increased from 0 % to 23.8 % ($p < 0.001$). After excluding unknown cases, the late period showed an increase in ER positivity from 68.1 % to 89.4 %, PR positivity from 60.9 % to 82.1 %, and decrease in HER2 negativity from 83.3 % to 71.4 % ($p < 0.001$). The proportion of surviving patients increased from 48.3 % to 72.2 %, and breast cancer-related mortality decreased from 24.1 % to 4.8 %. No significant differences in age at surgery, stage, or histological ductal type were observed between the periods.

3.5. Survival analysis by diagnosis period

Fig. 4 shows the survival curves for BCSS and OS in male patients categorized according to the diagnostic period. At 10 years, the BCSS rates were 79.1 % (95 % CI: 70.8 %–88.5 %) in the early group and 93.0 % (95 % CI: 89.5 %–96.6 %) in the late group. Similarly, at 10 years, the OS rates were 65.5 % (95 % CI: 56.3 %–76.3 %) in the early group and 66.6 % (95 % CI: 60.8 %–72.9 %) in the late group. After adjusting for age, type of surgery, disease stage, and ER/PR/HER2 status, the multivariate analysis revealed no significant results for BCSS and OS according to the year of diagnosis (Table 4). The adjusted HR for the year of diagnosis was 0.94 (95 % CI: 0.87–1.01, $p = 0.078$) for BCSS and 1.03 (95 % CI: 0.98–1.07, $p = 0.256$) for OS. These findings indicate that there was no improvement in survival outcomes among male breast cancer patients diagnosed in the recent years.

4. Discussion

We aimed to compare the long-term survival outcomes between male and female patients with breast cancer in an Asian population. After matching patients based on several demographic and clinical characteristics, we found no statistically significant differences in the BCSS rates between male and female patients. However, male patients had a significantly higher risk of all-cause mortality than female patients. Subgroup analysis further supported this finding, with males having a considerably lower OS than females based on ER status. The survival outcomes were affected by treatment methods such as radiation, and hormonal therapy. Our results are in line with those of previous studies reporting a lower survival rate among male patients [10,11]. Using the SEER database, Gnerlich et al. showed poorer survival among male patients with stage I disease. Li et al. reported inferior disease-free survival despite having equal stages in comparison to matched female patients. Our study provides additional evidence of the results from

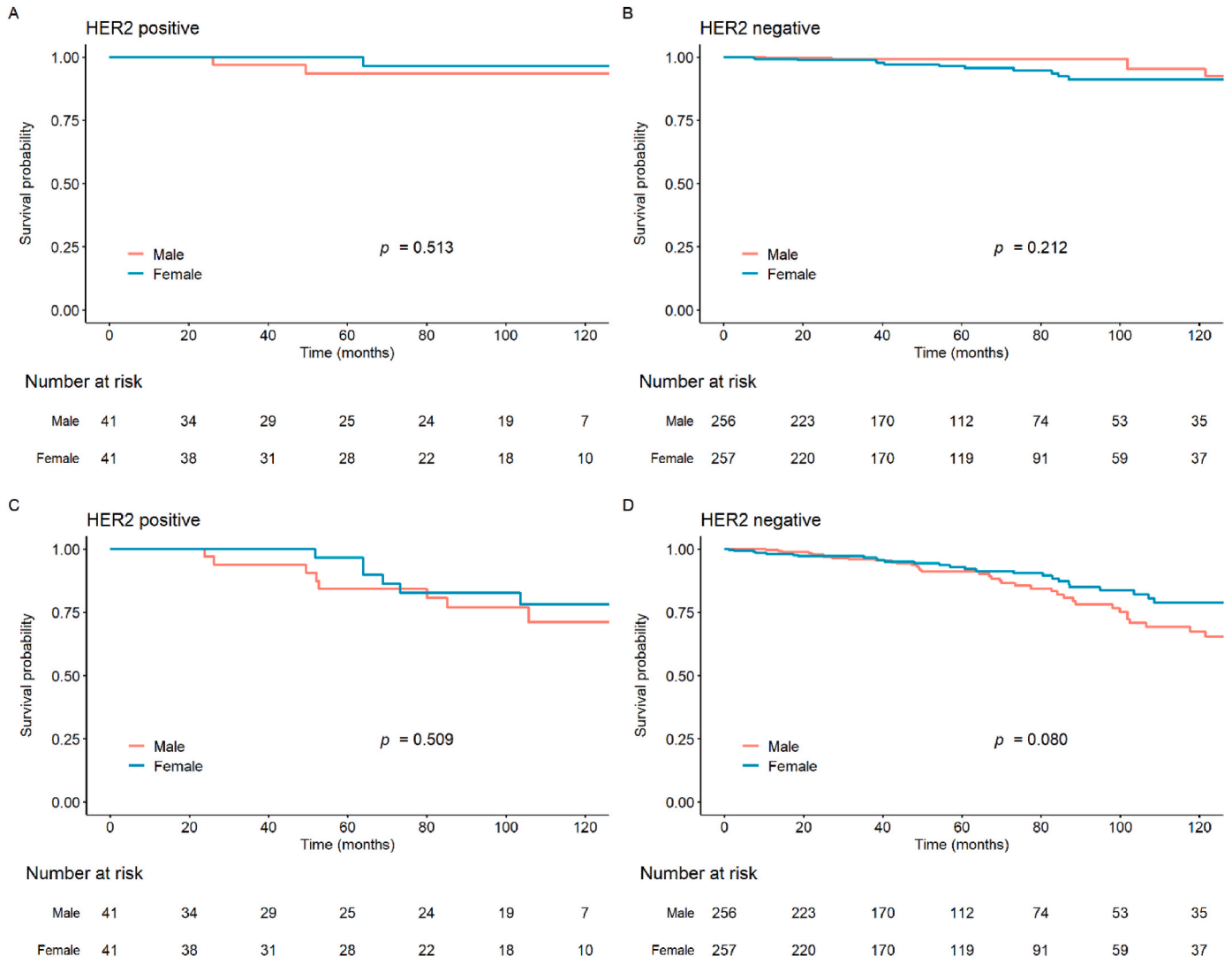

Fig. 3. Kaplan-Meier curve for (A–B) breast cancer-specific survival and (C–D) overall survival by HER2 status after matching.

these studies, as we included patients diagnosed over longer time periods and from nationwide Asian populations.

Male breast cancer is often diagnosed at a later stage than female breast cancer. This delayed diagnosis could be attributed to lower awareness of breast cancer risk in men and the lack of routine screening programs for men [12,13]. Later-stage diagnosis generally leads to worse prognosis and survival outcomes. Furthermore, differences in tumor characteristics such as molecular subtype and tumor size have been suggested as potential reasons for the observed differences in survival outcomes between male and female patients with breast cancer in previous studies [10,14,15]. However, after adjusting for these prognostic variables in our study, sex remained a significant predictor of all-cause mortality, indicating that other clinical factors may play ancillary roles in the differences in survival outcomes. Several other clinical factors contribute to the differences in breast cancer survival outcomes between male and female patients. This tends to lower the ability to tolerate aggressive therapies and shorten life expectancy independent of cancer [16–19]. Some studies have reported that higher rates of death from multiple comorbidities are a contributing factor to clinical outcomes in men with breast cancer. The risk of contralateral breast cancer and secondary primary cancers appears to be higher in men than in women with breast cancer [20–22]. In our dataset, the incidence of second primary malignancies was twice as high in male patients compared to female patients, which supports this observation.

Furthermore, male and female breast cancers have some inherent biological differences. Male patients with breast cancer are more likely to be ER-positive. Although this is generally associated with better outcomes in women, it may not confer the same advantages to men. Controversies exist regarding the benefits of treating male breast cancer with the same endocrine therapies used for female breast cancer, such as tamoxifen. Although it is known that the survival outcomes of male breast cancer patients have increased with the implementation of systemic endocrine therapy [23], [-25] the response of male and female breast cancers to tamoxifen might differ. A study showed that there was a 42 % decrease in breast cancer-specific mortality among women compared with only a 28 % decrease among men, suggesting that the treatments used for male breast cancer are not as effective as those used for female breast cancer [26]. Interestingly, in our results on Supplementary Fig. 5, male patients who received endocrine therapy demonstrated superior breast cancer-specific survival than female. Thus, male breast cancer, despite the expression of similar biomarkers, may be biologically different in some ways. Additionally, mutations in genes such as BRCA2 are more common in male patients. These biological variations may contribute to differing treatment responses and overall survival rates [27].

Interestingly, our study found no significant improvement in survival outcomes for male patients diagnosed with breast cancer in the late period compared to those in the early diagnostic period. This finding is

Table 3
Patient characteristics by period of diagnosis in male patients (N = 439).

Variables	Period of diagnosis			p
	1981–1999	2000–2010	Total	
All patients	87 (19.8)	352 (80.2)	439 (100.0)	
Age at surgery				0.253
<50	27 (31.0)	91 (25.9)	118 (26.9)	
50-64	36 (41.4)	130 (36.9)	166 (37.8)	
>64	24 (27.6)	131 (37.2)	155 (35.3)	
Surgery				0.008
Breast conservation surgery	3 (3.4)	39 (11.1)	42 (9.6)	
Mastectomy	80 (92.0)	300 (85.2)	380 (86.6)	
No surgery	2 (2.3)	13 (3.7)	15 (3.4)	
Others	2 (2.3)	0 (0.0)	2 (0.4)	
Axillary surgery				<0.001
ALND	79 (90.8)	201 (57.1)	280 (63.8)	
SLNB	0 (0.0)	35 (9.9)	35 (8.0)	
SLNB + ALND	0 (0.0)	49 (13.9)	49 (11.2)	
No surgery	6 (6.9)	56 (15.9)	62 (14.1)	
Unknown	2 (2.3)	11 (3.1)	13 (3.0)	
Pathologic tumor stage				0.001
Tis	4 (4.6)	16 (4.6)	20 (4.6)	
T1	37 (42.5)	176 (50.1)	213 (48.6)	
T2	28 (32.2)	118 (33.6)	146 (33.3)	
T3	7 (8.1)	6 (1.7)	13 (3.0)	
T4	8 (9.2)	9 (2.6)	17 (3.9)	
Unknown	3 (3.5)	26 (7.4)	29 (6.6)	
Pathologic nodal status				0.425
N0	44 (51.8)	204 (58.1)	248 (56.9)	
N1	23 (27.1)	75 (21.4)	98 (22.5)	
N2	10 (11.8)	29 (8.3)	39 (8.9)	
N3	5 (5.9)	18 (5.1)	23 (5.3)	
Unknown	3 (3.5)	25 (7.1)	28 (6.4)	
Disease stage				0.259
0	4 (4.6)	14 (4.0)	18 (4.1)	
1	24 (27.6)	125 (35.5)	149 (33.9)	
2	29 (33.3)	122 (34.7)	151 (34.4)	
3	18 (20.7)	49 (13.9)	67 (15.3)	
4	5 (5.8)	8 (2.3)	13 (3.0)	
Unknown	7 (8.1)	34 (9.7)	41 (9.3)	
Histology ductal type				0.676
Yes	64 (73.6)	251 (71.3)	315 (71.8)	
No	23 (26.4)	101 (28.7)	124 (28.2)	
ER				<0.001
Negative	15 (17.2)	28 (8.0)	43 (9.8)	
Positive	32 (36.8)	237 (67.3)	269 (61.3)	
Unknown	40 (46.0)	87 (24.7)	127 (28.9)	
PR				<0.001
Negative	18 (20.7)	47 (13.3)	65 (14.8)	
Positive	28 (32.2)	215 (61.1)	243 (55.4)	
Unknown	41 (47.1)	90 (25.6)	131 (29.8)	
HER2				<0.001
Negative	5 (5.8)	180 (51.1)	185 (42.1)	
Positive	1 (1.2)	35 (9.9)	36 (8.2)	
Borderline	0 (0.0)	37 (10.5)	37 (8.4)	
Unknown	81 (93.1)	100 (28.4)	181 (41.2)	
Endocrine therapy				0.030
SERM	22 (53.7)	176 (69.8)	198 (67.6)	
AI	0 (0.0)	12 (4.8)	12 (4.1)	
Others	4 (9.8)	15 (6.0)	19 (6.5)	
Not done	15 (36.6)	49 (19.4)	64 (21.8)	
Chemotherapy				0.433
Yes	27 (58.7)	167 (64.7)	194 (63.8)	
No	19 (41.3)	91 (35.3)	110 (36.2)	
Radiotherapy				0.640
Yes	10 (24.4)	52 (21.1)	62 (21.6)	
No	31 (75.6)	194 (78.9)	225 (78.4)	
Status				–
Alive	42 (48.3)	254 (72.2)	296 (67.4)	
Dead	45 (51.7)	98 (27.8)	143 (32.6)	
Cause of death				–
Alive	42 (48.3)	254 (72.2)	296 (67.4)	
Breast cancer	21 (24.1)	17 (4.8)	38 (8.7)	
Other cause	10 (11.5)	30 (8.5)	40 (9.1)	
Unknown cause	14 (16.1)	51 (14.5)	65 (14.8)	

ALND, axillary lymph node dissection; SLNB, sentinel lymph node biopsy; ER, estrogen receptor; PR, progesterone receptor; HER2, human epidermal growth factor receptor 2.

consistent with the results of recent clinical studies. Pizzaro et al. [28] analyzed the World Health Organization (WHO) data and showed no significant change in the mortality of male breast cancer between 2000 and 2017. Leone et al. [5] showed no statistically significant differences in the BCSS of men over the last three decades. Our study, which consists exclusively of Asian patients, may serve as important evidence supporting the findings of previous research. One possible explanation for the lack of survival improvement in men may be due to a lower efficacy of existing treatments in men compared with women. Another explanation for this is that the systemic therapy advances developed in women are either not used in men or not as effective in men as they are in women. Further research exploring the biologic differences of tumor for the treatment response between men and women is needed to elucidate these prognostic differences.

This study had several limitations. This study was conducted retrospectively using data from a prospectively maintained online registry, which may contain selection bias or incomplete information regarding the ER/PR/HER2 status. Our study did not consider potential confounding factors such as comorbidities, lifestyle factors or socioeconomic status, and the duration of endocrine therapy, which affect survival outcomes and may differ between male and female patients. Additionally, our study only included patients from South Korea, which may limit the generalizability of our findings to other populations or regions. Nevertheless, the strength of our research lies in the fact that we conducted propensity score matching to minimize selection bias and only focused on Asian male populations, which have been understudied in previous research. These results have important clinical implications for the management and treatment of male patients with breast cancer. These findings suggest the need for further investigation into the underlying reasons for the observed differences in survival outcomes between male and female patients, as well as the need for optimal treatment strategies that consider the unique characteristics of male patients with breast cancer. Our study highlights the need for increased awareness and education regarding breast cancer in men, which may contribute to earlier detection, timely intervention, and improved survival outcomes.

5. Conclusion

In this nationwide cohort study, we observed no improvement in survival outcomes among male breast cancer patients diagnosed in the recent years. Despite similar BCSS between sexes, male patients demonstrated significantly worse OS than female patients, likely due to higher non–cancer-related mortality.

CRediT authorship contribution statement

Nayeon Choi: Formal analysis, Visualization, Data curation. **Sohyun Moon:** Writing – review & editing, Formal analysis, Writing – original draft. **Jin Sung Kim:** Methodology, Project administration, Investigation. **Ah Yoon Kim:** Project administration, Investigation, Methodology. **Jee Hyun Ahn:** Methodology, Project administration, Data curation. **Yireh Han:** Project administration, Data curation, Methodology. **Joohyun Woo:** Investigation, Methodology, Data curation. **Hyunjik Kim:** Project administration, Data curation, Methodology. **Min Sung Chung:** Supervision, Writing – review & editing, Conceptualization. **Chihwan David Cha:** Writing – review & editing, Supervision, Conceptualization, Writing – original draft, Formal analysis.

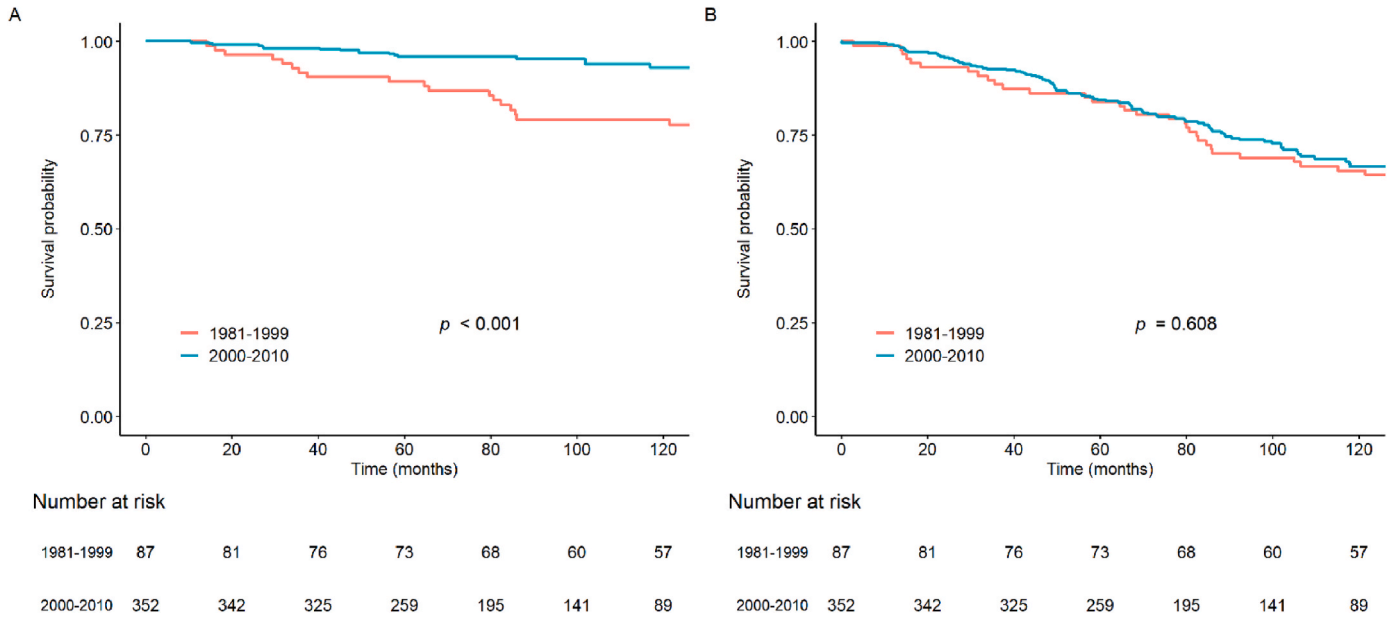

Fig. 4. Kaplan-Meier curve for (A) breast cancer-specific survival and (B) overall survival according to period of diagnosis in male patients.

Table 4
Multivariable Cox regression for breast cancer-specific survival and overall survival in male patients.

	Breast cancer-specific survival		Overall survival	
	HR (95 % CI)	p	HR (95 % CI)	p
Year of diagnosis	0.94 (0.87–1.01)	0.078	1.03 (0.98–1.07)	0.256

*Adjusted for age at surgery, breast surgery, axillary surgery, stage, ER status, PR status, and HER2 status.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Hanyang University Hospital (No. HYUH 2024-03-023) and followed the principles of the Declaration of Helsinki, which protects human subjects in medical research.

Consent for publication

Not applicable.

Data availability

The research data supporting the findings of this study are securely stored in an institutional repository and are available from the corresponding author upon reasonable request.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgements

The Korean Breast Cancer Society supported this study. The authors would like to thank Editage (www.editage.co.kr) for the English language editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.breast.2025.104556.

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