


# The Prevalence and Death Risk of Male Breast Cancer: A Study Based on the Surveillance, Epidemiology, and End Results Database

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## Abstract

This study was to investigate the prevalence and death risk of male breast cancer (MBC) patients. The prevalence trend was based on the Surveillance, Epidemiology, and End Results (SEER) database from 1975 to 2017. A competitive risk analysis was performed to analyze the death risk of MBC patients. Hazard ratio (HR) and 95% confidence intervals (CIs) were calculated. The results indicated that the prevalence of MBC after the standardization of the total population increased in 1975–2017 and its annual percentage change (APC) was 0.536% (95% CI = [0.362%, 0.713%]). The prevalence of MBC was rapidly increased in patients aged  $\geq 70$  years (APC = 0.780%; 95% CI = [0.491%, 1.076%]) and Grade II tumors (APC = 1.462%; 95% CI = [1.260%, 1.686%]). The 1-, 3-, and 5-year cumulative mortality of MBC patients who died of MBC was 2.23% (95% CI = [1.61%, 2.85%]), 7.56% (95% CI = [6.33%, 8.78%]), and 13.10% (95% CI = [11.10%, 11.32%]), respectively. Competitive risk analysis demonstrated that Blacks (HR = 1.76; 95% CI = [1.12, 2.77]), Grade 3 (HR = 2.56; 95% CI = [1.03, 6.35]), AJCC (American Joint Committee on Cancer) Stage III (HR = 3.04; 95% CI = [1.76, 5.26]), and AJCC Stage IV (HR = 7.27; 95% CI = [1.36, 38.83]) were associated with an increased MBC-specific death risk, whereas married status (HR = 0.40; 95% CI = [0.25, 0.64]), surgery (HR = 0.25; 95% CI = [0.12, 0.50]), Luminal A subtype (HR = 0.20; 95% CI = [0.07, 0.53]), and Luminal B subtype (HR = 0.29; 95% CI = [0.10, 0.87]) were related to a reduced MBC-specific death risk. In addition, similar results can be observed in patients with surgery recommended and done ( $p < .05$ ). This study may provide evidence for the prevalence trend, cumulative mortality, and death risk of MBC patients.

## Keywords

male breast cancer, prevalence trend, competitive risk analysis, risk factors of death

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## Introduction

Male breast cancer (MBC) is a rare and understudied disease, accounting for approximately 1% of all breast cancers (Giordano, 2018). In the United States in 2021, an estimated 2,650 MBC cases will be diagnosed and approximately 530 men are expected to die from this disease (Siegel et al., 2021). Previous studies indicate that the incidence of MBC seems to be increasing (Anderson et al., 2010; Kreiter et al., 2014). Data from the Surveillance, Epidemiology, and End Results (SEER) program indicate that the age-adjusted incidence rate has increased from 0.90 cases per 100,000 men in the general

population in 1980 to 1.32 cases per 100,000 in 2017 (SEER Program, 2021).

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Factors such as increasing age, BRCA gene mutations, radiation exposure, and elevated estrogen levels may trigger the occurrence of MBC (Giordano, 2018). The incidence risk for MBC increases with age, and compared with women, MBC tends to be diagnosed in the later stages of the disease (Anderson et al., 2010). The lifetime risk of breast cancer for a man is much lower than that for a woman (American Cancer Society, 2018). Due to the lower incidence, clinical studies on MBC always include relatively few cases, which makes a comprehensive analysis of MBC difficult. Research on the epidemiological trends of MBC based on big data samples is needed. In addition, the therapy for MBC is the same as the female breast cancer (Ly et al., 2013), but the prognosis of breast cancer in males was worse than in female patients (Iorfida et al., 2014). Although most studies on the prognosis of MBC have been conducted (Anderson et al., 2010; Wan et al., 2018), many of them ignore the role of other competing death causes in the prognosis of MBC when analyzing the overall survival of MBC.

Herein, we aimed to analyze the epidemiological characteristics of MBC based on the SEER database. Then, we analyzed the death risk of MBC patients and used competitive risk analysis to exclude the effects of other competing death-causing factors.

## Method

### Study Design and Population

Data of patients with MBC were collected from the SEER database submitted in April 2020. The *International Classification of Diseases for Oncology, Third Edition (ICD-O-3)* histology codes (8500, 8501, 8502, and 8503, etc.) were used to identify MBC cases. There are three SEER registration systems, including SEER 9, SEER 13, and SEER 18, covering 9.4%, 13.4%, and 27.8% of the entire American population, respectively. To maximize the representativeness of our study, we calculated the incidences of MBC using SEER 9 databases in 1975–1991, SEER 13 in 1992–1999, and SEER 18 in 2000–2017. Except for the incidence analysis (1975–2017), the other analyses were performed based on the SEER 18 databases from 2010–2017 due to the data of the HER2 molecular type were added in the database in 2010. This retrospective study was based on the publicly available de-identified data from the SEER database and did not involve interaction with human subjects or the use of personally identifying information. Therefore, this study did not need to be approved by the Institutional Review Board of the First Affiliated Hospital of Fujian Medical University.

### Inclusion and Exclusion Criteria

Patients were included when they met the following criteria: (a) MBC patients; (b) confirmed by pathological

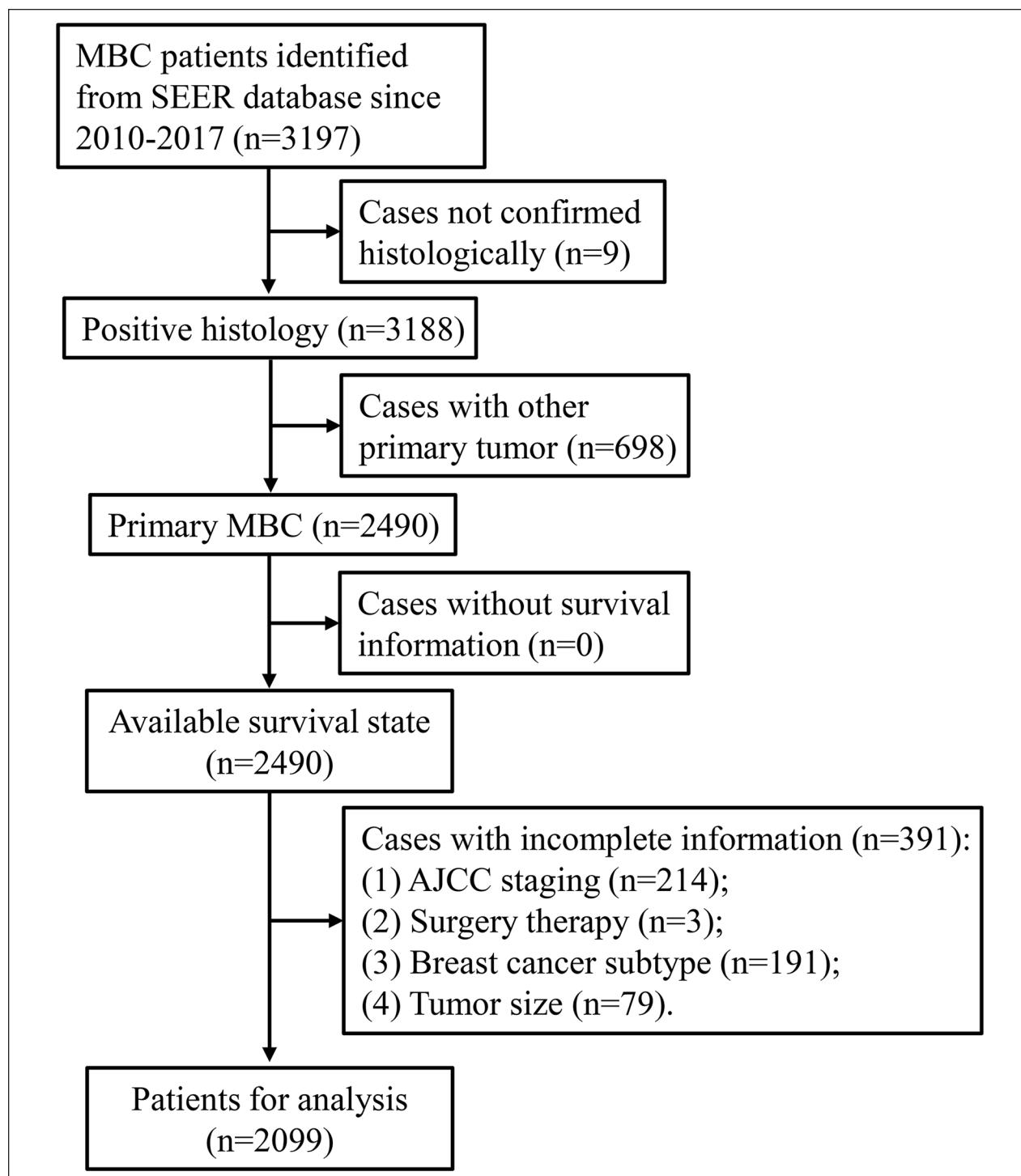
diagnosis; and (c) primary site tumor. Patients were excluded according to the following criteria: (a) patients without survival information; (b) unknown demographic information, including age and ethnicity; (c) unknown clinical information such as tumor laterality, clinical stage, and grade; and (d) patients with multiple primary tumors. A total of 3,197 MBC patients were selected from the SEER 18 database in 2010–2017 and 2,099 patients were eventually included for other analyses besides the incidence analysis (Figure 1). All included patients were divided into three groups according to the survival information: (a) MBC-specific death, (b) other cause-specific death, and (c) survival.

### Data Collection

Demographic and clinical data of MBC cases were extracted from SEER database. The demographic data of patients include age ( $\leq 50$ , 50–59, 60–69,  $\geq 70$  years), marital status (married, unmarried, others), ethnicity (White, Black, Others, unknown), region (metropolis, city, country), and average annual household income (US\$). Clinical data include tumor laterality (left, right), clinical grade (1, 2, 3), T stage (0, 1, 2, 3, 4), N stage (0, 1, 2, 3), M stage (0, 1), American Joint Committee on Cancer (AJCC, 7th edition) stage (0, I, II, III, IV), tumor size (mm), pathological type (invasive ductal carcinoma, intraductal papilloma, adenoma, others), primary site (nipple, central portion, upper-inner quadrant, lower-inner quadrant, upper-outer quadrant, lower-outer quadrant, axillary tail, overlapping lesion, breast-not otherwise specified), surgery (yes, no), surgery recommendations (surgery recommended and done, surgery not recommended, surgery recommended not done), radiation (yes, no, or unknown), molecular subtype (Luminal A, Luminal B, HER2 enriched, Triple negative), and survival months. According to the status of MBC patients at the end of follow-up, all included patients were divided into MBC-specific death group, other cause-specific death group, and survival group.

### Statistical Analysis

All statistical analyses were performed using the two-sided test and  $p < .05$  was considered to be statistically significant. SEER \* Stat software (Version 8.3.8, Surveillance Research Program, National Cancer Institute) was used to calculate the age-adjusted incidences standardized according to the U.S. standard population in 2000. The variation of MBC prevalence with the Joinpoint Regression Program (Version 4.8, Surveillance Research Program, National Cancer Institute) was assessed by annual percentage changes (APCs) and log-linear models. Continuous variables were described as median and interquartile range and the Kruskal–Wallis

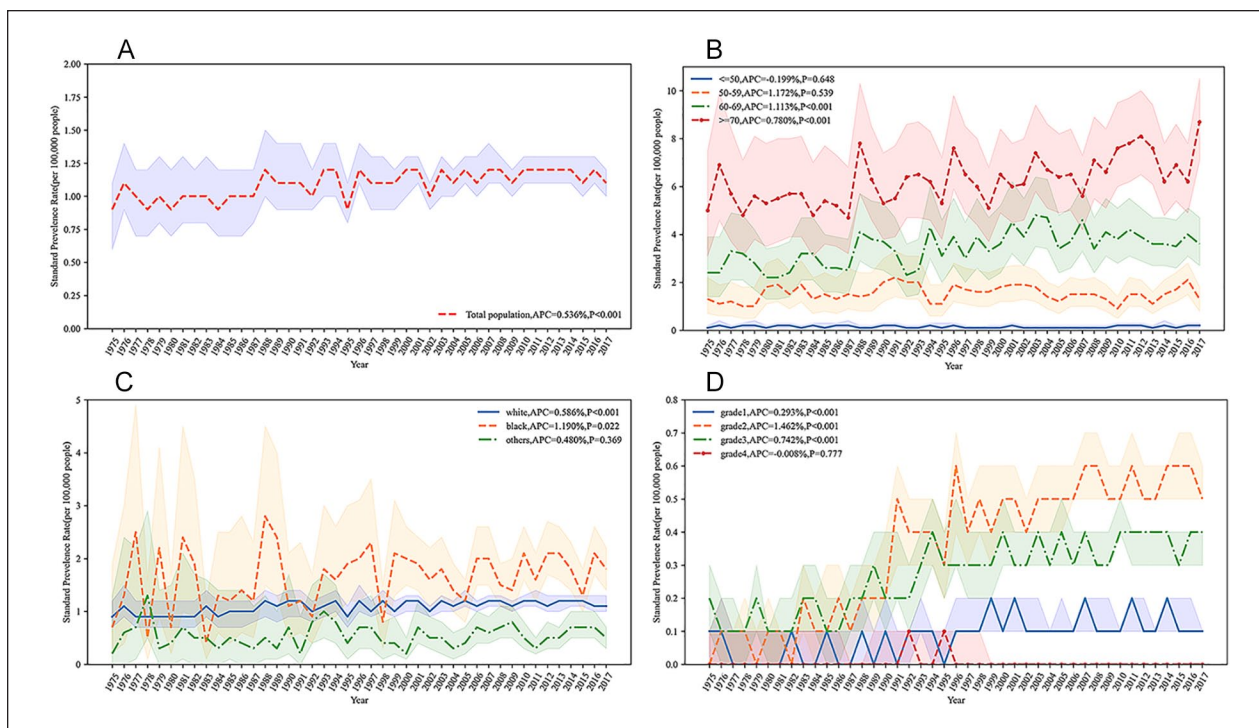


**Figure 1.** The Flowchart of Included Patients.

Note. MBC = male breast cancer; SEER = Surveillance, Epidemiology, and End Results; AJCC = American Joint Committee on Cancer.

test was used for comparison between groups. Categorical variables were described as numbers and percentages, and the chi-square test was used for comparison between groups. The descriptive analysis was performed by SAS

software (Version 9.4, SAS Institute, Cary, NC, USA). After descriptive analysis, the Fine-Gray test was used to analyze the differences in the mortality among MBC patients of different ages and the multivariate competitive



**Figure 2.** Standardized Annual Incidence of Male Breast Cancer From 1975 to 2017. (A) Total Standardized Annual Incidence of Male Breast Cancer; (B) Standardized Annual Incidence of Male Breast Cancer by Age; (C) Standardized Annual Incidence of Male Breast Cancer by Race; (D) Standardized Annual Incidence of Male Breast Cancer by Grade.

Note. APC = annual percentage change.

risk model was utilized to analyze the factors affecting MBC-specific death. In the competitive risk analysis, MBC-specific death and other cause-specific death were two competing endpoint events. The statistical analysis of this part was analyzed by R 4.0.3.

## Results

### Prevalence Trend of MBC

The prevalence of MBC after the standardization of the total population increased in 1975–2017, and its APC was 0.536% (95% confidence interval [CI] = [0.362%, 0.713%]; Figure 2A). Based on age group, the prevalence of MBC patients aged < 50 years and 50 to 59 years remained stable and their APCs were  $-0.199\%$  (95% CI =  $[-1.04\%, 0.65\%]$ ) and  $1.172\%$  (95% CI =  $[-0.371\%, 0.719\%]$ ), respectively. The prevalence of MBC was increased in patients aged 60 to 69 years and  $\geq 70$  years and their APCs were  $1.113\%$  (95% CI =  $[0.731\%, 1.55\%]$ ) and  $0.780\%$  (95% CI =  $[0.491\%, 1.076\%]$ ), respectively (Figure 2B). In the terms of race, the prevalence of MBC for Whites and Blacks was also increased, with APC of  $0.586\%$  (95% CI =  $[0.378\%, 0.796\%]$ ) and  $1.190\%$  (95% CI =  $[0.207\%, 2.197\%]$ ), respectively, whereas the prevalence of other races

remained stable (APC =  $0.480\%$ ; 95% CI =  $[-0.555\%, 1.529\%]$ ; Figure 2C). For clinical grade, except for Grade IV (APC =  $-0.008\%$ ; 95% CI =  $[-0.060\%, 0.044\%]$ ), the prevalence of other grades was all increased. Among which, the prevalence was from high to low for Grade II (APC =  $1.462\%$ ; 95% CI =  $[1.260\%, 1.686\%]$ ), Grade III (APC =  $0.742\%$ ; 95% CI =  $[0.609\%, 0.879\%]$ ), and Grade I (APC =  $0.293\%$ ; 95% CI =  $[0.173\%, 0.414\%]$ ; Figure 2D).

### Comparison of the Characteristics Between MBC-Specific Death, Other Cause-Specific Death, and Survival Groups

The results of the analysis indicated that there was statistical significance in patient's age ( $\chi^2 = 83.387$ ,  $p < .001$ ), marital status ( $\chi^2 = 32.607$ ,  $p < .001$ ), ethnicity ( $\chi^2 = 24.645$ ,  $p < .001$ ), average annual household income ( $H = 17.573$ ,  $p < .001$ ), clinical grade ( $\chi^2 = 19.886$ ,  $p < .001$ ), T stage ( $\chi^2 = 33.261$ ,  $p < .001$ ), N stage ( $\chi^2 = 26.205$ ,  $p < .001$ ), AJCC stage ( $\chi^2 = 53.505$ ,  $p < .001$ ), tumor size ( $H = 32.941$ ,  $p < .001$ ), surgery ( $\chi^2 = 28.712$ ,  $p < .001$ ), surgery recommendations ( $\chi^2 = 28.951$ ,  $p < .001$ ), molecular subtypes ( $\chi^2 = 18.751$ ,  $p < .001$ ), and survival months ( $H = 6.382$ ,  $p < .041$ ) in the three groups (Table 1).

**Table 1.** Comparison the Baseline Characteristics of Patients in the MBC-Specific Death Group, Other Cause-Specific Death Group, and Alive Group.

Characteristics	Group			Statistics	p
	MBC-specific death (n = 109)	Other cause- specific death (n = 206)	Survival (n = 1,784)		
Age (years), n (%)				$\chi^2 = 83.387$	<.001
≤50	12 (11.01)	2 (0.97)	185 (10.37)		
50–59	17 (15.06)	20 (9.71)	388 (21.75)		
60–69	42 (38.53)	51 (24.76)	601 (33.69)		
≥70	38 (34.86)	133 (64.56)	610 (34.19)		
Marital status, n (%)				$\chi^2 = 32.607$	<.001
Married	47 (43.12)	131 (63.59)	1,193 (66.87)		
Unmarried	34 (31.19)	28 (13.59)	253 (14.18)		
Others	28 (25.69)	47 (22.82)	338 (18.95)		
Ethnicity, n (%)				$\chi^2 = 24.645$	<.001
White	77 (70.64)	176 (85.44)	1,413 (79.20)		
Black	30 (27.52)	24 (11.65)	250 (14.01)		
Others	2 (1.83)	6 (2.91)	108 (6.05)		
Unknown	0 (0.00)	0 (0.00)	13 (0.73)		
Region, n (%)				$\chi^2 = 4.885$	.299
Metropolis	67 (61.47)	126 (61.17)	1,166 (65.36)		
City	30 (27.52)	66 (32.04)	462 (25.90)		
Country	12 (11.01)	14 (6.80)	156 (8.74)		
Average annual household income (\$), M (Q1, Q3)	6,827 (5,612, 7,795)	7,170 (6,169, 8,657)	7,443 (6,317, 9,136)	$H = 17.573$	<.001
Laterality, n (%)				$\chi^2 = 2.145$	.342
Left	66 (60.55)	110 (53.40)	952 (53.36)		
Right	43 (39.45)	96 (46.60)	832 (46.64)		
Grade, n (%)				$\chi^2 = 19.886$	<.001
1	6 (5.50)	25 (12.14)	224 (12.56)		
2	45 (41.28)	102 (49.51)	962 (53.92)		
3	58 (53.21)	79 (38.35)	598 (33.52)		
T stage, n (%)				$\chi^2 = 33.261$	<.001
0	0 (0.00)	0 (0.00)	1 (0.06)		
1	30 (27.52)	80 (38.83)	837 (46.92)		
2	60 (55.05)	92 (44.66)	785 (44.00)		
3	4 (3.67)	8 (3.88)	55 (3.08)		
4	15 (13.76)	26 (12.62)	106 (5.94)		
N stage, n (%)				$\chi^2 = 26.205$	<.001
0	42 (38.53)	117 (56.80)	1,015 (56.89)		
1	40 (36.70)	59 (28.64)	540 (30.27)		
2	14 (12.84)	24 (11.65)	153 (8.58)		
3	13 (11.93)	6 (2.91)	76 (4.62)		
M stage, n (%)				$\chi^2 = 2.941$	.230
0	107 (98.17)	206 (100.00)	1,763 (98.82)		
1	2 (1.83)	0 (0.00)	21 (1.18)		
AJCC stage, n (%)				$\chi^2 = 53.505$	<.001
0	0 (0.00)	0 (0.00)	1 (0.06)		
I	21 (19.27)	62 (30.10)	618 (34.64)		
II	47 (43.12)	98 (47.57)	888 (49.78)		
III	39 (35.78)	46 (22.33)	240 (13.45)		
IV	2 (1.83)	0 (0.00)	37 (2.07)		
Tumor size (mm), M (Q1, Q3)	25.00 (20.00, 35.00)	24.50 (18.00, 34.00)	21.00 (15.00, 29.00)	$H = 32.941$	<.001

(continued)



Table 1. (continued)

Characteristics	Group			Statistics	p
	MBC-specific death (n = 109)	Other cause-specific death (n = 206)	Survival (n = 1,784)		
Pathological type, n (%)				$\chi^2 = 6.522$	.367
Invasive ductal carcinoma	1 (0.49)	1 (0.92)	26 (1.46)		
Intraductal papilloma	185 (89.81)	102 (93.58)	1,610 (90.25)		
Adenoma	2 (0.97)	0 (0.00)	4 (0.22)		
Others	18 (8.74)	6 (5.50)	144 (8.07)		
Primary site, n (%)				$\chi^2 = 20.781$	.187
Nipple	4 (3.67)	14 (6.80)	90 (5.04)		
Central portion	52 (47.71)	89 (43.20)	764 (42.83)		
Upper-inner quadrant	5 (4.59)	5 (2.43)	79 (4.43)		
Lower-inner quadrant	1 (0.92)	4 (1.94)	28 (1.57)		
Upper-outer quadrant	8 (7.34)	26 (12.62)	222 (12.44)		
Lower-outer quadrant	4 (3.67)	7 (3.40)	74 (4.15)		
Axillary tail	0 (0.00)	1 (0.49)	2 (0.11)		
Overlapping lesion, n (%)	15 (16.59)	21 (10.19)	296 (16.59)		
Breast, NOS	20 (12.84)	39 (18.93)	229 (12.84)		
Surgery, n (%)				$\chi^2 = 28.712$	<.001
Yes	97 (88.99)	188 (91.26)	1,728 (96.86)		
No	12 (11.01)	18 (8.74)	56 (3.14)		
Surgery recommendations, n (%)				$\chi^2 = 28.951$	<.001
Surgery recommended and done	97 (88.99)	188 (91.26)	1,728 (96.86)		
Surgery not recommended	8 (7.34)	11 (5.24)	36 (2.02)		
Surgery recommended not done	4 (3.67)	7 (3.40)	20 (1.12)		
Radiation, n (%)				$\chi^2 = 4.507$	.105
Yes	81 (74.31)	159 (77.18)	526 (29.48)		
No or unknown	28 (25.69)	47 (22.82)	1,258 (70.52)		
Subtype, n (%)				$\chi^2 = 18.751$	<.001
Luminal A	83 (85.44)	176 (85.44)	1,541 (86.38)		
Luminal B	20 (18.35)	30 (14.56)	206 (11.55)		
HER2 enriched	1 (0.92)	0 (0.00)	13 (0.73)		
Triple negative	5 (4.59)	0 (0.00)	24 (1.35)		
Survival months, M (Q1, Q3)	31.00 (17.00, 44.00)	26.50 (12.00, 47.00)	32.00 (13.00, 56.00)	$H = 6.382$	<.041

Note. Metropolis, population over 1 million. MBC = male breast cancer; AJCC = American Joint Committee on Cancer; NOS = not otherwise specified.

### Analysis on the Cumulative Mortality of MBC Patients

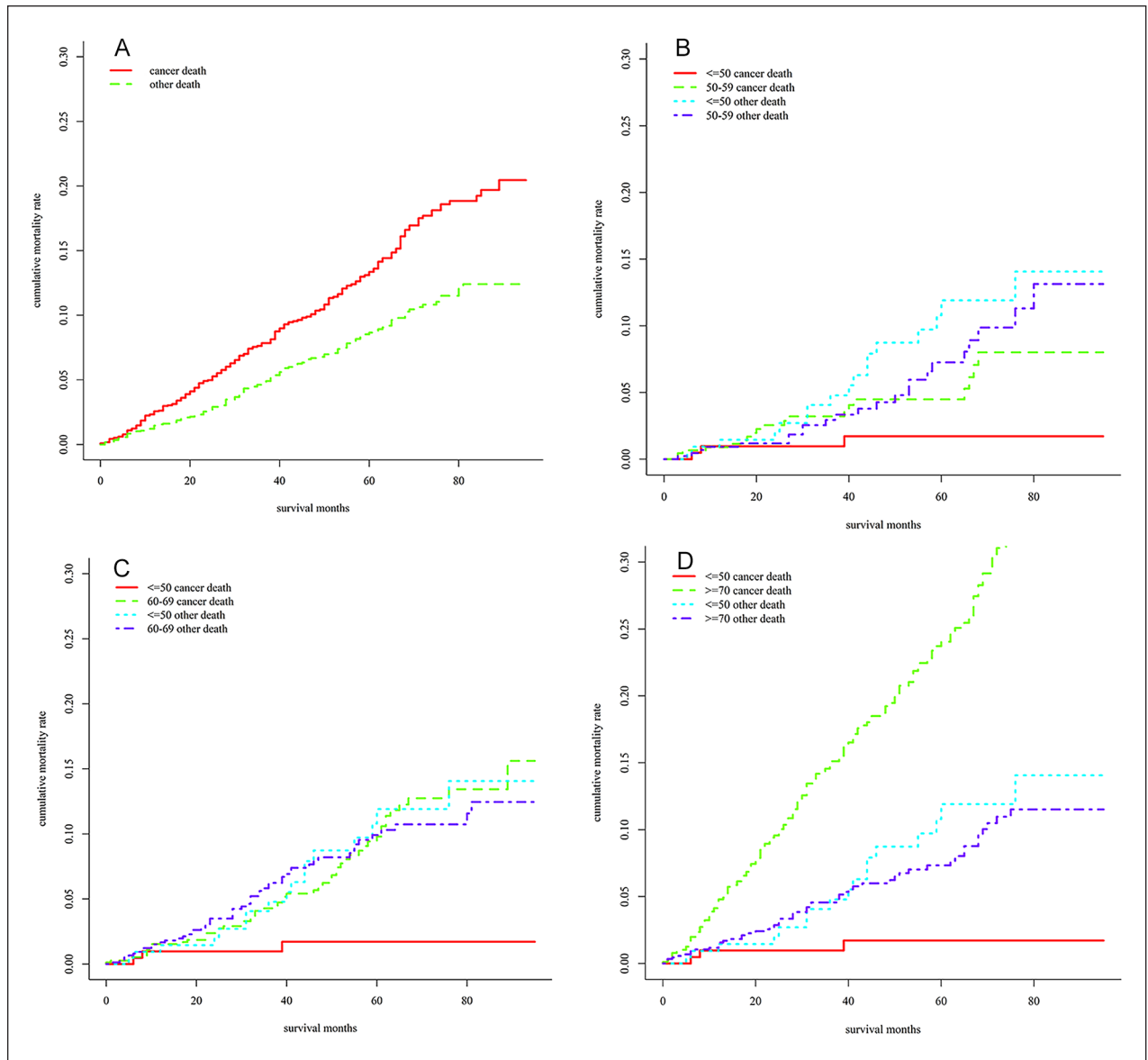
The 1-, 3-, and 5-year cumulative mortality of patients who died of MBC was 2.23% (95% CI = [1.61%, 2.85%]), 7.56% (95% CI = [6.33%, 8.78%]), and 13.10% (95% CI = [11.10%, 11.32%]), respectively, whereas the 1-, 3-, and 5-year cumulative mortality of MBC patients died of other diseases was 1.46% (95% CI = [0.96%, 1.96%]), 5.59% (95% CI = [4.49%, 6.70%]), and 9.79% (95% CI = [8.10%, 11.47%]), respectively (Figure 3A).

Further analysis about the cumulative mortality of MBC patients at different ages was performed. Compared

with patients  $\leq 50$  years old, patients at the age of 50 to 59 ( $\chi^2 = 4.294$ ,  $p = .038$ ; Figure 3B), 60 to 69 ( $\chi^2 = 11.302$ ,  $p < .001$ ; Figure 3C), and  $\geq 70$  ( $\chi^2 = 40.221$ ,  $p < .001$ ; Figure 3D) had a higher MBC-specific cumulative mortality, after adjusting for death from other diseases.

### Competitive Death Risk Analysis of MBC Patients

A competitive risk model was constructed to analyze the factors affecting the MBC-specific death of MBC patients. The results demonstrated that Blacks (hazard



**Figure 3.** Cumulative Mortality of Male Breast Cancer Patients. (A) Total Cumulative Mortality; (B) Comparison of Cumulative Mortality Between  $\leq 50$  Years Group and 50 to 59 Years Group; (C) 60 to 69 Years Group; (D)  $\geq 70$  Years Group.

ratio [HR] = 1.76; 95% CI = [1.12, 2.77]), Grade 3 (HR = 2.56; 95% CI = [1.03, 6.35]), AJCC Stage III (HR = 3.04; 95% CI = [1.76, 5.26]), and AJCC Stage IV (HR = 7.27; 95% CI = [1.36, 38.83]) were associated with an increased MBC-specific death risk in overall MBC patients, whereas married status (HR = 0.40; 95% CI = [0.25, 0.64]), surgery (HR = 0.25; 95% CI = [0.12, 0.50]), Luminal A subtype (HR = 0.20; 95% CI = [0.07, 0.53]), and Luminal B subtype (HR = 0.29; 95% CI = [0.10, 0.87]) were related to decreased MBC-specific death risk. Among patients with surgery recommended and done, similar results can be observed ( $p < .05$ ), and

radiation (HR = 0.61; 95% CI = [0.37, 0.99]) was also associated with a reduced MBC-specific death risk (Table 2).

## Discussion

In this study, we analyzed the prevalence trend of MBC from 1975 to 2017 based on SEER databases. The prevalence of MBC has increased gradually with APC of 0.536%, and it was rapidly increased in patients aged  $\geq 70$  years or at Grade II. The 1-, 3-, and 5-year MBC-specific cumulative mortality of patients was 2.23%,

**Table 2.** The Results of Competitive Death Risk Analysis in MBC Patients.

Factors	All MBC patients		MBC patients with surgery recommended and done	
	HR (95% CI)	<i>p</i>	HR (95% CI)	<i>p</i>
Marital status				
Unmarried	Reference		Reference	
Married	0.40 [0.25, 0.64]	<.001	0.43 [0.27, 0.70]	<.001
Others	0.78 [0.46, 1.32]	.348	0.78 [0.45, 1.35]	.376
Race				
Whites	Reference		Reference	
Blacks	1.76 [1.12, 2.77]	.0147	1.91 [1.18, 3.09]	.009
Others	0.48 [0.11, 2.00]	.3120	0.24 [0.03, 1.82]	.168
Grade				
I	Reference		Reference	
2	1.49 [0.61, 3.63]	.377	1.53 [0.56, 4.16]	.408
3	2.56 [1.03, 6.35]	.043	2.89 [1.04, 8.05]	.043
AJCC stage				
I	Reference		Reference	
II	1.45 [0.84, 2.51]	.185	1.80 [0.97, 3.36]	.064
III	3.04 [1.76, 5.26]	<.001	4.71 [2.48, 8.95]	<.001
IV	7.27 [1.36, 38.83]	.020	28.43 [3.26, 248.18]	.003
Surgery				
No	Reference		—	—
Yes	0.25 [0.12, 0.50]	<.001	—	—
Radiation				
No	—	—	Reference	
Yes	—	—	0.61 [0.37, 0.99]	.043
Subtype				
Triple negative	Reference			
Luminal A	0.20 [0.07, 0.53]	.001	0.18 [0.06, 0.55]	.016
Luminal B	0.29 [0.10, 0.87]	.027	0.23 [0.07, 0.76]	.003
HER2 enriched	0.32 [0.03, 3.34]	.342	0.31 [0.03, 3.66]	.350

Note. MBC = male breast cancer; HR = hazard ratio; CI = confidence interval; AJCC = American Joint Committee on Cancer.

7.56%, and 13.10%, respectively. The MBC-specific cumulative mortality of patients in the 50 to 59 years group, 60 to 69 years group, and  $\geq 70$  years group was higher than those in the  $\leq 50$  years group. In addition, we conducted a competitive risk analysis on the factors affecting the MBC-specific death and found that Blacks, Grade 3, AJCC Stage III, AJCC stage IV, married status, surgery, and Luminal A and B subtype subtypes possibly affected the MBC-specific death of patients.

The occurrence of MBC may be related to many factors, including demographic factors (age, race, etc.), genetic factors (*BRCA1* and 2, etc.), environmental factors (radiation exposure), and hormonal factors (increased serum estradiol, liver disease, obesity, etc.; Giordano, 2018). MBC is an age-related disease, the incidence rates of which raise steadily with age (American Cancer Society, 2018). The BRCA mutation is one of the clearest risk factors for MBC (Antoniou et al., 2003). Previous studies have shown that some of MBC patients (0%–4%)

have *BRCA1* mutations and some (4%–16%) have *BRCA2* mutations (Basham et al., 2002; Ding et al., 2011; Ottini et al., 2003). In addition, radiation exposure has been reported as a risk factor for breast in men (Little & McElvenny, 2017). Importantly, MBC is highly sensitive to hormonal changes. The occurrence risk of MBC may be increased by some diseases related to abnormal estrogen exposure or imbalance of estrogen/androgen ratio, such as Klinefelter syndrome, obesity, and liver disease (Brinton et al., 2014; Ottini, 2014). This study analyzed the prevalence trend of MBC from 1975 to 2017 based on SEER databases. The results showed that the prevalence of MBC has increased gradually with APC of 0.536%. In particular, it was rapidly increased in patients aged  $\geq 70$  years or at Grade II. The prevalence of patients with Grade II and III has increased significantly, especially for patients with Grade II, whereas the prevalence of patients with Grade IV and I increased slowly. The possible reason for the higher detection rate of early-stage tumors



may be related to the development of detection technology (Gao et al., 2018).

We used the competitive risk analysis to explore the factors that affected the MBC-specific death of MBC patients. Our results suggested that Blacks, Grade 3, AJCC Stage III, and AJCC Stage IV were related to an increased MBC-specific risk, whereas married status, surgery, and Luminal A and B subtypes were associated with reduced MBC-specific risk. Taylor et al. reported that the relative survival rate of Blacks with MBC was lower than that of Whites and Hispanics (Ellington et al., 2020). In terms of marital status, Adekolujo et al. found that married men with Stage II, III, and IV MBC had significantly better 5-year cancer-specific survival rates compared with unmarried men (Adekolujo et al., 2017). The main reason seems to be that married people can get more psychological support (Baine et al., 2011). Sarmiento et al. (2020) revealed that surgery can significantly improve survival in MBC patients. Furthermore, the association between shorter surgery time and improved survival is well recognized (Bleicher et al., 2016; Mansfield et al., 2017; Polverini et al., 2016). Among different molecular types of MBC, patients with Luminal A type exhibited a lower death risk than those with other types. Another study also supported that Luminal A type was associated with better overall survival (Sánchez-Muñoz et al., 2018; Schildhaus et al., 2013; Yu et al., 2013).

Age played an important role in the occurrence and prognosis of MBC. It was reported that the average age of man diagnosed with breast cancer is approximately 5 years older than that of women (67 vs. 62 years; Giordano et al., 2004). Our results displayed that the MBC-specific cumulative mortality of MBC patients in the 50 to 59 years group, 60 to 69 years group, and  $\geq 70$  years group was higher than those in the  $\leq 50$  years group. According to reports, approximately one third of MBC patients were aged  $< 60$ , one third aged 60 to 69, and one third aged  $\geq 70$  (Ellington et al., 2020). Our results also demonstrated that age may not be related to the MBC-specific death risk. Previous studies also supported our results that age was not associated with the MBC-specific death but with all-cause death in MBC patients (Cardoso et al., 2018; Cronin et al., 2018).

## Limitations and Strengths

We analyzed the prevalence trend of MBC from 1975 to 2017 by using SEER database from and explored the factors affecting the death of MBC patients through competitive risk analysis. The cumulative mortality of MBC at 1, 3, and 5 years was calculated and further analyzed based on age. However, this study has some limitations. First, the biochemical indicators that might cause the death of MBC patients were not explored because of their deficiency in the SEER database. Second, except the

analysis of prevalence trends, other analyses were based on the data from 2010 to 2017 because the data of HER2 molecular type in the SEER database did not exist until 2010. Third, the database lacked other detailed treatment information, such as information on the use of drugs during chemotherapy.

## Conclusion

The prevalence of MBC has increased gradually and it was rapidly increased in patients aged  $\geq 70$  or at Grade II. The MBC-specific cumulative mortality of MBC patients in the 50 to 59 years group, 60 to 69 years group, and  $\geq 70$  years group were higher than those in the  $\leq 50$  years group. The competitive risk analysis showed that Blacks, Grade 3, AJCC Stage III, AJCC Stage IV, married status, surgery, and Luminal A and B subtypes were possible factors affecting the death of MBC patients.

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