The Breast 57 (2021) 36–42

Contents lists available at ScienceDirect

The Breast

journal homepage: www.elsevier.com/brst

Original article

Risk factors associated with loss to follow-up of breast cancer patients: A retrospective analysis

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ARTICLE INFO

Article history:
Received 15 October 2020
Received in revised form
5 February 2021
Accepted 17 February 2021
Available online 2 March 2021

Keywords:
Breast cancer
Loss to follow-up
Surveillance
Risk score

ABSTRACT

Background: Loss to follow-up (LTFU) during post-operative surveillance of breast cancer patients is detrimental. The pattern of LTFU and its risk factors in Chinese breast cancer patients remains unknown.
Method: Eligible non-metastatic breast cancer patients who underwent surgery at our institution between 2009 and 2012 were included. The clinicopathological features, as well as the LTFU status, were retrieved from the REDCap database. LTFU was defined as the absence of patients for at least 12 months since her last contact. 5-year LTFU was defined as the LTFU status of each patients at 5 years after surgery. The incidence and potential risk factors of LTFU were analyzed. A LTFU-risk score was developed to quantify the risk of LTFU.
Results: A total of 1536 patients with breast cancer were included, and 411(26.8%) patients were 5-year LTFU. 198 patients were LTFU in the first year. Univariate and multivariate analysis revealed that age (younger and older), a lack of medical insurance, longer distance from residence to the hospital, pathology (DCIS/Paget's/Phyllodes), lymph node metastasis, the absence of endocrine therapy and fewer than five contact numbers were significantly and independently associated with the risk of LTFU. A LTFU-risk score was developed and was predictive of LTFU.
Conclusions: A series of risk factors were significantly associated with post-operative LTFU of breast cancer patients. Patients with different risks of LTFU could possibly be identified, and surveillance plans could be individualized for different patients, so as to effectively reduce the overall LTFU rate, and optimize the allocation of medical resources.

1. Introduction

Breast cancer is the most common female malignancy in China, with an age-standardized incidence rate of 30.54/100,000 people in 2015 [1], and its incidence has increased significantly over the past three decades, growing annually by 3–5% [2–4]. The median 5-year relative survival across previous studies was 88% [5–11], suggesting that most patients will be long-term survivors. As a result, the need to manage post-operative adverse events, as well as monitor recurrence/death highlights the necessity of post-operative follow-up. From the perspective of clinical research, high-quality surveillance/follow-up data are prerequisite to assure the validity and

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https://doi.org/10.1016/j.breast.2021.02.012

integrity of retrospective/case-control studies. Loss to follow-up (LTFU) and/or noncompliance to the surveillance plan are detrimental to the reliability of clinical research [12]. Furthermore, LTFU might increase the risk of non-adherence to endocrine therapy, which might compromise long-term diseases control. Thus, it is important to analyze the risk factors of LTFU. For patients with a high risk of LTFU, different surveillance plans or educational programs for patients could be designed to decrease the likelihood of LTFU.

The factors associated with LTFU were described in previous studies [13–15]. However, most of these studies were conducted in Western countries. Because patients with breast cancer in China areon average, 10 years younger than their Western counterparts [16–18], in addition to the distinct cultural and socioeconomic environment of the country, it is necessary to explore the risk factors of LTFU in the Chinese breast cancer population. To our knowledge, the risk factors of LTFU remain largely unknown.

In the breast tumor center of Sun Yat-sen Memorial Hospital (SYSMH), Sun Yat-sen University, patients with breast cancer were educated to return to the clinic for follow-up, based on the surveillance plan suggested by the National Comprehensive Cancer Network guidelines [19]. This study investigated the LTFU rate of the patients with breast cancer in our single institution. Additionally, we explored the potential risk factors of LTFU.

2. Materials and methods

We included patients with non-metastatic (stage 0/TIS, I, II and III) breast cancer who underwent breast-conserving surgery or mastectomy at SYSMH between January 1, 2009 and December 31, 2012 from the Research Electronic Data Capture (REDCap), maintained by SYSMH [20,21]. For eligible patients, we collected their demographic information, staging, pathology, treatment, recurrence/death, and the date of the last follow-up. Patients were instructed to return to the clinic for post-operative follow-up visits every 3 months for the first 2 years after surgery, every 6 months for years 3–5 after surgery, and annually thereafter. For patients who did not return to the clinic as scheduled, we did not have any programs to contact or inform them. In this study, we retrieved the information of the patients' return visits from REDCap. LTFU was defined as the absence of patients for at least 12 months since her last contact. The date of LTFU was defined as the date of the patient's last contact. The time to LTFU was defined as the interval between the date of surgery and the LTFU date. The primary endpoint of this study was the 5-year LTFU rate.

2.1. Statistical analysis

Descriptive analyses of baseline demographic and clinicopathological features were conducted. Continuous variables were reported as the median and range, and categorical variables were reported as percentages. To analyze the potential risk factors of 5-year LTFU, we used univariate and multivariate logistic regression analyses. In this study, $P < 0.05$ denoted statistical significance. Data analyses were performed using Stata version 15.1 software (StataCorp, College Station, TX, USA). This study was approved by the ethical committee of SYSMH.

3. Results

In total, 1536 eligible patients with pathologically confirmed breast cancer who underwent surgery between 2009 and 2012 at SYSMH were identified via REDCap (Table 1). Among these patients, 97(6.32%) patients died within 5 years after surgery, and they were not considered in the 5-year LTFU analysis. Meanwhile, 411(26.76%) patients were lost to follow-up within 5 years, and 198 patients were considered lost to follow-up within 1 year (Fig. 1). The median time to LTFU was 13.2 months (interquartile range: 3.98–30.39).

Univariate analysis illustrated that age (≤39/≥55 vs. 40–54), year of diagnosis (2009 vs. 2011/2012), type of residence (countryside vs. city), distance between patients' residence and the hospital (longer vs. shorter), GDP levels of the area of residence (lower vs. higher), and medical insurance status (uninsured vs. insured) were significantly associated with LTFU (Table 2). Other socioeconomic factors, such as educational level, marital status, and religion, were not associated with LTFU. We further explored the impact of the completeness of the personal information provided by the patients. We observed that patients who provided more ways of contact (≥5 vs. 0/1) and a residential addresses (Yes vs. No) were less likely to be lost to follow-up. Furthermore, we observed that patients with minimally invasive tumors (T0/Tis vs. T2/T1) were more likely to be lost to follow-up. Patients who were diagnosed with phyllodes tumors or ductal carcinoma in situ (DCIS) were also more likely to be lost to follow-up. In addition, no receipt (vs. receipt) of adjuvant chemotherapy, radiotherapy, and endocrine therapy was significantly associated with LTFU.

To identify independent risk factors associated with 5-year LTFU, we used a logistic regression model (Table 3) and observed that age (younger and older), a lack of medical insurance, longer distance from residence to the hospital, pathology (DCIS/Paget's/phyllodes), lymph node metastasis, the absence of endocrine therapy and fewer than five contact numbers were significantly and independently associated with the risk of LTFU.

To codify the possible impact of the risk factors, we developed a LTFU risk score based on the risk factors of each patient (Table 4). We observed that the LTFU risk score was significantly associated with the LTFU ($P < 0.00001$) (Fig. 2).

4. Discussion

This was the first to investigate the risk factors of LTFU in patients with breast cancer after surgery in China. In our study, the LTFU rate of 26.8% (median follow-up, 51.7 months) represented an acceptable and natural attrition rate without any intervention in postoperative patients compared with rates of 10%–50% described in previous studies [13,14,22]. Consistent with previous studies, older age, longer distance to the hospital, lymph node metastasis, and a lack of endocrine therapy were significant risk factors of LTFU [14,22]. Furthermore, we have new findings that tumor pathology (DCIS/Paget's/phyllodes), younger age, a lack of medical insurance, fewer ways of contact were also associated with the tendency to LTFU.

4.1. The importance of preventing LTFU

Post-operative surveillance and follow-up are required for breast cancer survivors to deliver medical care, improve health-related quality of life, ensure compliance to endocrine therapy, and support clinical research, as high-quality data for clinical outcomes would be necessary for hypothesis generation during clinical research [23]. The National Accreditation Program For Breast Centers and European Society of Breast Cancer Specialists accreditation programs, which aim to accredit breast treatment centers in North American and European countries, respectively, required the development of a standard survivorship care plan [24,25]. The American Society of Clinical Oncology also determined the minimum data elements that need to be collected during surveillance [12]. The importance of surveillance and follow-up for patients with breast cancer is not extensively recognized in China.

Additionally, survivorship tends to be longer for breast cancer

Table 1
Demographic and clinicopathological characteristics of patients.

Features	N = 1536	Features	N = 1536
LTFU at 5 years after surgery		T-Stage	
No	1125 (73.2)	T0/Tis	153 (10.0)
Yes	411 (26.8)	T1	609 (39.6)
Age group of diagnosis		T2	410 (26.7)
<=39 y	309 (20.1)	T3/T4	52 (3.4)
40–54 y	750 (48.8)	Tx/Unknown	312 (20.3)
>=55 y	477 (31.1)	**N-Stage**	
mean 49y, median 48y(20-91y)		N0	948 (61.7)
Year of surgery		N1	361 (23.5)
2009	313 (20.4)	N2/N3	227 (14.8)
2010	321 (20.9)	**ER status**	
2011	423 (27.5)	Negative	322 (21.0)
2012	479 (31.2)	Positive	1194 (77.7)
Type of residence		Unknown	20 (1.3)
City	1182 (77.0)	**PR Status**	
Countryside	354 (23.0)	Negative	441 (28.7)
Education level		Positive	1075 (70.0)
Primary school	300 (19.5)	Unknown	20 (1.3)
Middle school	839 (54.6)	**HER2 Status**	
University	356 (23.2)	Negative	929 (60.5)
Unknown	41 (2.7)	Positive	306 (19.9)
Marital status		Intermediate	270 (17.6)
Single	61 (4)	Unknown	31 (2.0)
Married	1457 (94.9)	**Type of breast surgery**	
Divorced/Widowed	18 (1.2)	Mastectomy	696 (45.3)
Religions		BCS	840 (54.7)
No	1469 (95.6)	**Type of axillary surgery**	
Yes	51 (3.3)	ALND	682 (44.4)
Unknown	16 (1.0)	SLNB	854 (55.6)
Medical insurance		**Adjuvant chemotherapy**	
Insured	1034 (67.3)	No	175 (11.4)
Uninsured	469 (30.5)	Yes	1361 (88.6)
Unknown	33 (2.1)	**Anti-Her2 therapy**	
Distance from residence to hospital		No	1464 (95.3)
Less than 100 km	746 (48.6)	Yes	72 (4.7)
More than 100 km	790 (51.4)	**Adjuvant endocrine therapy**	
GDP level of the patients' residence		No	184 (12.0)
More than 100,000 CNY	902 (58.7)	Yes	1254 (81.6)
Less than 100,000 CNY	526 (34.2)	Unknown	98 (6.4)
Unknown	108 (7.0)	**Adjuvant radiotherapy**	
Comorbidities		No	343 (22.3)
No	1214 (79.0)	Yes	858 (55.9)
Yes	322 (21.0)	Unknown	335 (21.8)
Pathology		**Amount of the ways of contacts provided**	
DCIS/Paget's/Phyllodes tumor	160 (10.4)	None/1	303 (19.7)
IDC	1300 (84.6)	2–4	1126 (73.3)
Others	76 (4.9)	≥5	107 (7.0)
Grade		**Amount of the addresses provided**	
I	112 (7.3)	None	148 (9.6)
II	459 (29.9)	≥1	1388 (90.4)
III	429 (27.9)	**Employer/Company was provided**	
Not available	536 (34.9)	No	1285 (83.7)
		Yes	251 (16.3)

AbbreviationsALND, Axillary lymph node dissection; GDP, Gross domestic product; CNY, ChineseYuan; BCS, Breast-conserving surgery; DCIS, Ductal carcinoma in situ; ER, Estrogen receptor; HER2, Human epithelial growth factor receptor-2; IDC, Infiltrative ductal carcinoma; LTFU, Loss to follow-up; PR, Progesterone receptor; SLNB, Sentinel lymph node biopsy.

survivors than for survivors of other solid cancers. Thus, the completeness of follow-up data, especially those related to clinical outcomes (e.g., relapse, breast cancer death), is critical for clinical research. Although numerous methods were proposed to correct the bias induced by LTFU, it is impossible to eliminate its detrimental effects for data analysis [26]. The Cochrane Handbook, a guide for high-quality systematic reviews of published literature, considers LTFU as an important source of bias that needs to be addressed and evaluated [27].

4.2. The risk factors of LTFU

Currently, the post-operative surveillance/follow-up program for patients with breast cancer suggested by NCCN guidelines aims to monitor breast cancer relapse without any consideration to providing different intensities of follow-up for patients with different LTFU risks [19]. To optimize the allocation of medical resources during follow-up, investigating the underlying risk factors of LTFU is important. However, the risk factors of LTFU have not been widely studied. Kukar et al. investigated patients with breast cancer in the USA and concluded that older age at diagnosis, tumor stage, longer driving distance from home to the cancer center, prior cancer recurrence, and last visit at a surgical oncology rather than a medical oncology clinic were risk factors for LTFU [22]. Ruddy et al. reported that older age; non-white race; no prior receipt of radiation, chemotherapy, and endocrine therapy; and increasing time

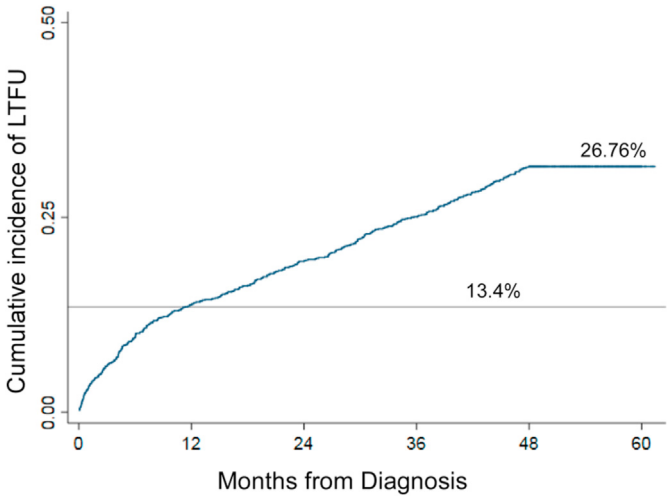

Fig. 1. Cumulative incidence of LTFU (Loss to follow-up) of the study cohort.

after surgery were significantly correlated with LTFU among patients with breast cancer [14]. However, socioeconomic factors vary among different countries, which might significantly contribute to the different results found in different countries. Thus, it is necessary to investigate the patterns of LTFU and its risk factors in female Chinese patients with breast cancer. In our study, we noticed additional risk factors of LTFU that were not previously reported [14,22].

4.3. Younger age

The studies by Kukar et al. and Ruddy et al. did not find an association between younger age and LTFU risk [22,28]. However, we observed that younger patients (age $\leq$ 39 years) were more likely to experience LTFU than those 40–54 years old for several reasons. First, with the rapid economic development of China, the migration of women from rural areas to urban areas has continuously increased since the late 1970s, and young women comprise the most mobile population [29,30]. Thus, once they move to another city, the likelihood of LTFU might increase. Second, young patients are more likely to engage in busy work. As the main workforce of society, young women (age $\leq$ 39 years) work longer hours than their counterparts in Western countries [31,32]. Consequently, busier women may have less time to adhere to clinical advice and visit the clinic as suggested, which may contribute to LTFU.

4.4. Lack of insurance

In our study, we observed that uninsured patients (469/1536, 30.5%) were more likely to be lost to follow-up. The result may be attributed to two reasons. First, uninsured patients are more likely to have less education and lower income, which are usually associated with compromised breast cancer awareness and reduced adherence to post-operative surveillance plans. Another reason for these associations could be the misclassification of the insurance type in our medical system, which is a limitation of our study. For patients who were not living in Guangzhou (the city in which our hospital is located), their medical insurance might not always be correctly updated in our HIS system, hence, some patients might be mistakenly labeled as "uninsured." Therefore, these patients might receive follow-up surveillance at their local hospitals, leading to an increased risk of LTFU. They might also receive a higher reimbursement rate. China has a unique social health insurance system in which patients might receive less reimbursement if they do not receive medical treatment in their own residence area [33,34]. As reported by Yao et al., local residents under a social health insurance scheme were more likely to seek medical attention when needed and leave a health record than patients who were outside of their area of residence [35].

4.5. Ways of contact

Special attention should be paid to the number of provided contacts. We noticed that patients with $\geq$5 ways of contact were less likely to be lost to follow-up. This result has strong implications for medical institutions in China. Because the aforementioned risk factors of LTFU, including the medical insurance and lymph node status, cannot be controlled by the center, additional ways of contact should be collected in daily practice, especially for patients with high risks of LTFU. We suggested the collection of contact information from patients as well as their relatives, families, or friends with their informed consent. Even if the patient moves to another city and changes the mode of contact, we could easily communicate with him or her by contacting his or her relatives, families, or friends. For patients who refuse or who were unable to provide additional means of contact, we should educate and inform them about the benefits of providing additional contact information. Furthermore, contact details should be continuously updated. To reduce the risk of loss of contact because of changes of patients' residence and employment, new contact information should be routinely collected during follow-up care.

4.6. Pathology

Patients with DCIS/Paget's/phyllodes tumors were more likely to be lost to follow-up than those with IDC because the former tumors are less invasive than IDC and patients were not fully aware of the necessity of follow-up. In addition, a lack of adjuvant therapy for DCIS/Paget's/phyllodes tumors may also contribute to LTFU.

4.7. The clinical implications of the characteristics of LTFU

Because reducing the risk of LTFU is extremely important, our study may be informative for dealing with this problem. In our study, 26.8% of patients were lost to follow-up at 5 years after surgery, and half of them were lost to follow-up within 1 year after surgery, underlining the necessity of the first follow-up visit within the first 12 months after surgery. More intensive follow-up plan could be considered for patients within the first 1 year after surgery.

Furthermore, we found risk factors that independently associated with LTFU, and the risk of LTFU was dramatically increased when two or more of the aforementioned risk factors were present, prompting close attention for these "high-risk" patients. To quantify the impact of the possible risk factors, an LTFU risk score was developed to evaluate the risk of LTFU for each patient and design individualized follow-up plans. Less or more intensive follow-up plans could be suggested for patients with low and high LTFU risk scores, respectively, to optimize the allocation of medical resources. For patients at high risk of LTFU, we could consider several approaches. First, patients could be informed of the importance of post-operative follow-up during the peri-operative period and as in the clinic. In addition, the only modifiable factor of the LTFU risk score is the number of ways of contact. During the disease registration, more additional contact information (phone number/email address/WeChat account) were suggested to be collected from patients as well as their family members. Moreover, consistently updating patient contact information during post-operative follow-

Table 2
Univariate analysis of demographic and pathologic characteristics associated with LTFU.

Variable	OR(95%CI)	P	Variable	OR(95%CI)	P
Age group of diagnosis			**T-stage**		
40–54 y	1		T0/Tis	1	
≤ 39 y	1.45(1.08–1.94)	0.013	T1	0.56(0.38–0.83)	0.004
≥ 55 y	1.29(1.00–1.68)	0.051	T2	0.67(0.45–1.01)	0.056
Year of surgery			T3/T4	1.28(0.67–2.47)	0.448
2009	1		Tx/Unknown	1.11(0.73–1.66)	0.630
2010	1.04(0.74–1.45)	0.831	**N-stage**		
2011	0.72(0.52–0.01)	0.046	N0	1	
2012	0.68(0.49–0.95)	0.010	N1	0.86(0.66–1.15)	0.321
Type of residence			N2/N3	1.28(0.89–1.67)	0.221
City	1		**ER status**		
Countryside	1.71(1.32–2.21)	<0.001	Negative	1	
Education level			Positive	0.78(0.59–1.02)	0.071
Primary school	1		Unknown	5.41(2.02–14.50)	0.001
Middle school	082(0.61–1.09)	0.175	**PR status**		
University	0.83(0.60–1.18)	0.313	Negative	1	
Unknown	1.29(0.62–2.45)	0.558	Positive	0.75(0.59–0.96)	0.025
Marital status			Unknown	5.43(2.03–14.37)	0.001
Single	1		**HER2 status**		
Married	1.12(0.62–2.03)	0.707	Negative	1	
Divorced/Widowed	1.53(0.49–4.80)	0.462	Positive	1.10(0.82–1.47)	0.528
Religions			Intermediate	0.92(0.67–1.26)	0.620
No	1		Unknown	4.52(2.16–9.44)	<0.001
Yes	1.39(0.77–2.51)	0.279	**Type of breast surgery**		
Unknown	1.26(0.44–3.66)	0.668	Mastectomy	1	
Medical insurance			BCS	0.87(0.69–1.09)	0.213
Insured	1		**Type of axillary surgery**		
Uninsured	2.28(1.80–2.90)	<0.001	ALND	1	
Unknown	2.11(1.02–4.36)	0.043	SLNB	1.01(0.80–1.27)	0.944
Distance from residence to hospital			**Adjuvant chemotherapy**		
Less than 100 km	1		No	1	
More than 100 km	2.70(2.12–3.42)	<0.001	Yes	0.59(0.43–0.83)	0.002
GDP level of the patients' residence			**Anti-HER2 therapy**		
More than 100,000 CNY	1		No	1	
Less than 100,000 CNY	2.13(1.67–2.70)	<0.001	Yes	0.59(0.32–1.09)	0.091
Unknown	3.07(2.03–4.64)	<0.001	**Adjuvant endocrine therapy**		
Comorbidities			No	1	
No	1		Yes	0.45(0.32–0.62)	<0.001
Yes	0.83(0.62–1.10)	0.195	Unknown	1.87(1.14–3.06)	0.014
Pathology			**Adjuvant radiotherapy**		
DCIS/Paget's/Phyllodes tumor	1		No	1	
IDC	0.49(0.35–0.69)	<0.001	Yes	0.68(0.51–0.91)	0.008
Others	0.44(0.25–0.84)	0.012	Unknown	1.49(1.08–2.05)	0.016
Grade			**Amount of the ways of contacts provided**		
I	1		0–1	1	
II	0.77(0.48–1.24)	0.277	2–4	0.69(0.52–0.90)	0.007
III	0.97(0.61–1.57)	0.917	≥5	0.40(0.23–0.70)	0.001
Not available	1.40(0.88–2.22)	0.152	**Amount of the addresses provided**		
			None	1	
			≥1	0.50(0.35–0.70)	<0.001
			Employer/Company was provided		
			No	1	
			Yes	0.73(0.53–1.01)	0.059

AbbreviationLTFU, Loss to follow-up; GDP, Gross domestic product; CNY, Chinese Yuan; DCIS, Ductal carcinoma in situ; IDC, Invasive ductal carcinoma; ALND, Axillary lymph node dissection; BCS, Breast-conserving surgery; ER, Estrogen receptor; HER2, Human epithelial growth factor receptor-2; PR, Progesterone receptor; SLNB, Sentinel lymph node biopsy. OR, Odds ratio; CI, Confidence interval.

up is also recommended.

4.8. Limitations

Nevertheless, some limitations of this study must be addressed. First, this was a single-center, retrospective study with inherent bias that cannot be eliminated. Multicenter, prospective studies are necessary to validate our conclusions, especially the accuracy of our LTFU risk scores. Second, some personal information such as family income, occupation, and personal psychosocial status/personality, which may influence the risk of LTFU, was not available in our study. Third, we were unable to identify the exact cause of LTFU in our study, which might be especially important to improve our surveillance plans in clinical practice. A possible strategy to solve this problem could be collaboration with different hospitals, medical societies, the CDC, and related governmental departments and utilization of artificial intelligence technology to trace these patients. We believe that with the development of community hospitals and a network of family doctors, a well-coordinated surveillance network could be established in the future.

It should be noted that for patients who did not return to the clinic as scheduled at our institution, we did not have any ways to contact or inform them before 2015. However, the breast disease registry department was established in our center in 2015, and subsequently, all newly admitted patients have been prospectively followed, and the 5-year LTFU rate in the new tracking system has

Table 3
Multivariate analysis identifying factors associated with LTFU.

Variables	OR(95%CI)	P
Age group of diagnosis		
40–54 y	1	
≤39 y	1.37(1.00–1.88)	0.05
≥55 y	1.46(1.10–1.94)	0.009
Type of residence		
City	1	
Countryside	1.11(0.81–1.51)	0.525
Medical insurance		
Insured	1	
Uninsured	1.57(1.20–2.06)	0.001
Unknown	1.62(0.75–3.50)	0.217
Distance from residence to hospital		
Less than 100 km	1	
More than 100 km	2.06(1.37–3.11)	0.001
GDP level of the patients' residence		
More than 100,000 CNY	1	
Less than 100,000 CNY	1.00(0.67–1.49)	0.993
Unknown	1.37(0.80–2.35)	0.251
Pathology		
DCIS/Paget's/Phyllodes tumor	1	
IDC	0.59(0.40–0.89)	0.012
Others	0.51(0.26–0.99)	0.047
N-stage		
N0	1	
N1	1.01(0.74–1.38)	0.938
N2/N3	1.53(1.07–2.19)	0.02
Adjuvant chemotherapy		
No	1	
Yes	0.72(0.49–1.07)	0.106
Anti-HER2 therapy		
No	1	
Yes	0.58(0.30–1.11)	0.099
Adjuvant endocrine therapy		
No	1	
Yes	0.51(0.36–0.71)	0
Unknown	1.35(0.78–2.33)	0.282
Adjuvant radiotherapy		
No	1	
Yes	0.83(0.60–1.14)	0.25
Unknown	1.25(0.87–1.81)	0.227
Amount of the ways of contacts provided		
0-1	1	
2-4	0.86(0.64–1.16)	0.325
≥5	0.52(0.29–0.94)	0.029
Amount of the addresses provided		
None	1	
≥1	0.94(0.63–1.40)	0.773
Employer/Company was provided		
No	1	
Yes	1.01(0.71–1.44)	0.94

AbbreviationLTFU, Loss to follow-up; GDP, Gross domestic product;;CNY, Chinese Yuan; HER2, Human epidermal growth factor receptor-2; DCIS, Ductal carcinoma in situ; IDC, Invasive ductal carcinoma; OR, Odds ratio; CI, Confidence interval.

Table 4
LTFU-risk score.[a].

Predictors	Score
Age group of diagnosis (≤39y or ≥ 55y)	1
Medical insurance (Uninsured)	1
Distance from residence to hospital (More than 100 km)	1
Pathology (DCIS/Paget's/Phyllodes tumor)	1
N-stage (N2/N3)	1
Adjuvant endocrine therapy (No)	1
Amount of the ways of contacts provided (<5)	1

Abbreviation: LTFU, Loss to follow-up; DCIS, Ductal carcinoma in situ.
[a] LTFU-risk score was the sum of the total score above, ranging between 0 and 6.

been less than 5% (unpublished data). With the development of high-speed Internet and mobile social media, such as WeChat

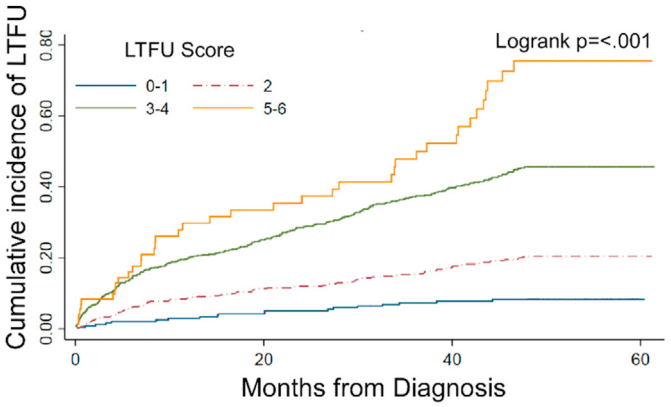

Fig. 2. Cumulative incidence of LTFU (Loss to follow-up) based on the LTFU-risk score of each patient.

[36,37], interactive text message follow-up systems, patients are more easily contacted than in the past [38]. Furthermore, annual meetings for cancer survivors hosted by our center would presumably also help to decrease the likelihood of LTFU after surgery, but further studies are needed to confirm this speculation.

Our study is the first research investigating LTFU in patients with breast cancer in China, its patterns and risk factors, and also a potential LTFU-risk score which could be used to predict the risk of LTFU in clinical practice. We suggest that patients with higher risks of LTFU should be identified, and more individualized surveillance plans should be delivered to decrease their LTFU risks and therefore to improve their clinical outcomes.

Authors' contributions

QO, SL, MG, LZ, SX, SM, SW and LH contributed to the conception of the study, data acquisition and design of the study. QO drafted the article. FS, ZR, KC and MP revised the paper for important intellectual content. KC and MP provided final approval of the version to be submitted.

Funding information

This study was funded by the Yat-sen Scholarship of Young Scientist program of Sun Yat-sen Memorial Hospital, Sun Yat-sen University (Recipient: Kai Chen), and by the grants from the Sun Yat-sen Clinical Research Cultivating Program of Sun Yat-sen Memorial Hospital, Sun Yat-sen University (#SYS-Q-202002, Recipient: Liling Zhu). This study was also supported by the Sun Yat-sen University Clinical Research 5010 Program (#2018022, Recipient: Kai Chen), as well as by the National Natural Science Foundation of Guangdong Province (# 2019A1515011467, Recipeint: Shunrong Li.).

Ethical approval

Ethical approval was waived by the local Ethics Committee of Sun Yat-sen Memorial Hospital in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.

Statement of informed consent

This is a retrospective study and we used data from a database, we do not need informed consent from the patients.

Declaration of competing interest

The authors have no relevant financial disclosures or conflict of interest to declare.

Acknowledgements

We appreciate the assistance from the Disease Registry Department, the Artificial Intelligence Lab and the Big Data Center of Sun Yat-sen Memorial Hospital, Sun Yat-sen University. We also appreciate the support from REDCap development team and research teams of Vanderbilt University Medical Center.

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