Incidence, mortality and survival of female breast cancer during 2003-2011 in Jiangsu province, China

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Abstract

Objective: To assess the incidence, mortality and survival status of female breast cancer in Jiangsu province of China.

Methods: Population-based cancer registry data in Jiangsu province were collected during 2003-2011. Crude rates, age-specific rates, age-standardized rates and annual percent changes of incidence and mortality were calculated to describe the epidemiologic characteristics and time trends. Patients diagnosed from 2003 to 2005 were chosen for analyzing the survival status of breast cancer.

Results: From 2003 to 2011, 17,605 females were diagnosed with breast cancer and 4,883 died in selected registry areas in Jiangsu province. The crude incidence rate was 25.18/100,000, and the age-standardized rates by Chinese population (ASRC) and by world population (ASRW) were 19.03/100,000 and 17.92/100,000, respectively. During the same period, the crude mortality rate was 6.98/100,000 and the ASRC and ASRW were 4.93/100,000 and 4.80/100,000, respectively. From 2003 to 2011, the incidence and mortality increased with annual percent change of 11.37% and 5.78%, respectively. For survival analysis, 1,392 patients in 7 areas were identified in 2003-2005 and finished 5 years of follow-up. Survival rates were found to decrease with survival years, the 5-year observed survival rate was 45.9% and the relative survival rate was 52.0%. We also found that the survival rate varied across the province, which was lower in the north and higher in the south of Jiangsu province.

Conclusions: Breast cancer has become a significant public health problem in Jiangsu province and China. More resources should be invested in primary prevention, earlier diagnosis and better health services in order to increase survival rates among Chinese females.

Keywords: Breast cancer; incidence; mortality; observed survival; relative survival; Jiangsu province

Introduction

Breast cancer is one of the most common malignancies and has become a serious threat to women's health around the world. In 2012, 1.67 million women were diagnosed with breast cancer worldwide, accounted for 25.2% of all cancers among women. Meanwhile, 522,000 women died of breast cancer which accounted for 14.7% of all female cancer deaths in 2012 (1). Interestingly, the risk of this disease varies significantly across the world. Comparing with Western countries, the incidence and mortality of breast cancer in China are at relatively lower levels. According to the statistics of International Agency for Research on Cancer (IARC), the age-standardized incidence

rate of female breast cancer in China was 22.1/100,000 in 2012, while the age-standardized mortality was 5.4/100,000 (2). However, because of the large population size, the number of cases in China is higher than that in most countries. Chen reported that there were almost 269,000 women joined the group of breast cancer in China, and the deaths were 69,500 at the same time (3).

In the past decades, incidences of female breast cancer in most countries and regions have increased by 30%–40% (4), but this increasing trend was more obvious in China. From 1980 to 1990, the crude incidence has increased by 72% with an annual growth of 3%–4%, which was far above the world average (5,6). On the other hand, the crude mortality of breast cancer in China also increased by approximately 100% since 1970s (5.90/100,000 in 2004-2005 *vs.* 2.95/100,000 in 1970s) (4). The fast increase of breast cancer risk in China is partly associated with its economy booms and rapid changing lifestyles.

Comparing with cancers of high fatality such as lung cancer and liver cancer, the prognosis of breast cancer is much better (7). Population-based cancer survival could reflect the prognosis of cancer and evaluate the progress of disease control, and is also helpful in making policies to ensure improved and equitable cancer care. Besides, cancer survival can also help establish strategies to improve cancer treatment. However, only a few cancer registries have carried out population-based survival statistics for breast cancer among the Chinese people in recent years, results showed that the survival rates have been significantly improved (8-10), but still much lower than many developed countries such as the United States, Australia and some European countries (7). Being lack of historical cancer registry data, the epidemiologic characteristics of female breast cancer in China, such as long-term change of incidence, mortality and survival rates, still need further investigation.

Jiangsu province is an eastern coastal province in China with a population of 79 million. Although being one of the developed areas in China, Jiangsu province is an area with high incidence and mortality of malignant tumors. According to the Second National Death Retrospective Survey in early 1990s, the mortality of cancer was 160/100,000, which is 48.15% higher than the national average (108/100,000) (11). As a big province in China, the long-term change of female breast cancer still needs further illustration, furthermore, population-based survival analysis of this disease has not been conducted previously yet. The purposes of this study are to describe the incidence, mortality and the temporal trend of female breast cancer in Jiangsu province, and to analyze the survival status of breast cancer patients in the province.

Materials and methods

Data source

Data were collected from Jiangsu Province Cancer Registry, which is affiliated with Jiangsu Provincial Center for Disease Control and Prevention. Cancer registry in Jiangsu province was first initiated in 1970s in Qidong County and has experienced quick development since 2000 (12). Now the whole province has been covered by cancer registry system, however, only a few counties could provide population-based registry data dating back to early 2000.

There were 7 registries providing integrate data in 2003, then with the improvement of cancer registry work, the registered points were gradually increased in the following years and until 2011 there were 29 registries providing integrate data. These data were selected to analyze the incidence and mortality of female breast cancer. For survival analysis, patients who were diagnosed as breast cancer between January 1, 2003 and December 31, 2005 were recruited and followed up for at least 5 years. A mix of active and passive follow-up methods was used to identify the vital status of patients from the date of diagnosis. In total, 7 counties provided complete survival information and passed quality evaluation. Among the 7 counties, 1 is in the south of Jiangsu province, 3 in the middle and 3 in the north.

Information of breast cancer patients including personal information (name, age, birth date, address, etc.) and diagnostic information (onset date, diagnostic basis, date of death, ICD-10 code, etc.) were collected using standardized cancer registry card.

Quality control

According to the data quality standards from International Agency for Research on Cancer/International Association of Cancer Registration (IARC/IACR), Software including MS-FoxPro, MS-Excel and IARCcrgTools (IARC/IACR) was used to inspect and assess the quality of data. The reliability, validity and integrity were evaluated by major indices including proportion of morphological verification (MV%), percentage of cases diagnosed with death certification only (DCO%) and mortality to incidence ratio (M/I). In this study, the MV% of female breast cancer was 84.72%, DCO% was 0.52% and M/I was 0.28, which indicated that data quality met the criteria of data quality of breast cancer (13).

Statistical analysis

Crude incidence and mortality were calculated by using the number of new cases or death cases divided by the population in

registry areas during the same period. Rates were standardized by using 2000 Chinese standard population (ASRC) and Segi's world population (ASRW) (14). Age-specific rates were calculated for 19 age groups. Time trends during 2003-2011 were estimated by annual percent change (APC), which was calculated with the following formula: $APC=100\times(e^{\beta}-1)$, coordinated with the model $y=\alpha+\beta x+\varepsilon$, wherein α is constant term, β is the slope calculated from a linear regression of log rates in a calendar year and ε means random error (15,16).

Life-table method was utilized to compute the observed survival (OS) and Ederer II method was used to estimate expected survival via the Stata software 12.0 (StataCorp LP, College Station, Texas, USA) (17). In addition to OS, relative survival (RS), a comprehensive index which can represent the excess mortality of cancer when other mortality risk was removed, was also calculated by dividing the OS of patients by the expected survival of a comparable group in the general population (18). Standardized RS was adjusted by the International Cancer Survival Standards (ICSS) (19).

Results

Incidence and mortality

In selected cancer registry areas of Jiangsu province, from 2003 to 2011, the observed total population size was 140,465,998 and 69,911,221 were females. Meanwhile, 17,605 women were diagnosed with breast cancer, accounted for 11.72% and ranked the 4th of all female cancer cases. The annual average crude incidence was 25.18/100,000 with an ASRC and ASRW of 19.03/100,000 and 17.92/100,000, respectively. There were 4,883 women died from breast cancer during the same period, accounted for 5.09% and ranked the 6th of total female cancer deaths. The annual average crude mortality was 6.98/100,000 with the ASRC and ASRW of 4.93/100,000 and 4.80/100,000, respectively (*Table 1*).

The temporal trends of breast cancer are shown in *Figure 1* and *Figure 2*. Significant upward trends were observed for both incidence and mortality from 2003 to 2011, although there are some fluctuations between years. As listed in *Table 1*, the crude incidence increased from 13.17/100,000 to 31.62/100,000 with an APC of 11.37% (P<0.01), and the crude mortality increased from 4.86/100,000 to 7.74/100,000 with an APC of 5.78% (P<0.01). After age standardization, the increasing trends became smooth but still obvious (*Figure 1,2*).

Table 2 displays the age-specific incidence and mortality of female breast cancer in registry areas of Jiangsu province. It was obvious that both incidence and motility increased with age. Among women after 30 years old, the incidence increased

Table 1 Incidence and mortality for female breast cancer in Jiangsu province, 2003–2011 (1/10^5)

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	All	APC	P
Counties	7	8	8	9	13	14	17	27	29			
Population	2,900,593	3,535,623	3,530,560	6,624,543	6,201,561	8,730,479	7,925,604	14,164,103	16,298,155	69,911,221		
Incidence												
Cases	382	519	537	1,479	1,382	2,457	1,940	3,755	5,154	17,605		
Crude rate (1/10^5)	13.17	14.68	15.21	22.33	22.28	28.14	24.48	26.51	31.62	25.18	11.37	0.0002
ASRC (1/10^5)	10.55	11.81	12.25	17.09	18.28	20.24	18.29	19.81	23.39	19.03	9.98	0.0002
ASRW (1/10^5)	9.88	11.16	11.56	16.06	17.31	19.23	17.06	18.51	22.00	17.92	9.99	0.0003
Mortality												
Deaths	141	198	215	396	380	626	623	1,043	1,261	4,883		
Crude rate (1/10^5)	4.86	5.60	6.09	5.98	6.13	7.17	7.86	7.36	7.74	6.98	5.78	0.0001
ASRC (1/10^5)	3.75	4.27	4.61	4.36	4.69	4.89	5.41	5.07	5.27	4.93	3.94	0.0005
ASRW (1/10^5)	3.58	4.11	4.45	4.15	4.55	4.81	5.31	4.94	5.15	4.80	4.27	0.0006

APC, annual percent change; ASRC, the age-standardized rate by Chinese population; ASRW, age-standardized rate by world population.

rapidly with age growth and reached the peak at age of 55–59 years (63.01/100,000), then stayed at a high level and decreased slightly until 85+ years again (51.24/100,000). Similarly, the mortality also reached its first peak at age of 55–59 years (20.08/100,000), and the highest rate occurred at age of 85+ years (32.16/100,000) (*Figure 3*).

Survival analysis

From January 1, 2003 to December 31, 2005, there being 1,392 breast cancer cases recruited for survival analysis in selected registry areas. All subjects were followed for at least 5 years and
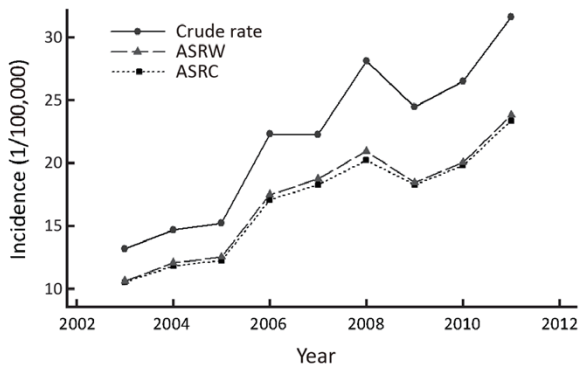

Figure 2 Mortality trend of female breast cancer in Jiangsu province, 2003-2011.

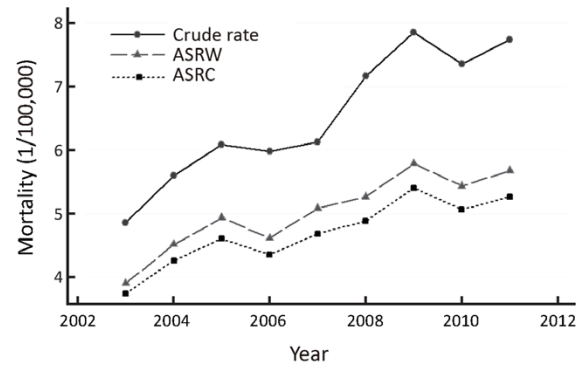**Figure 1** Incidence trend of female breast cancer in Jiangsu province, 2003-2011.
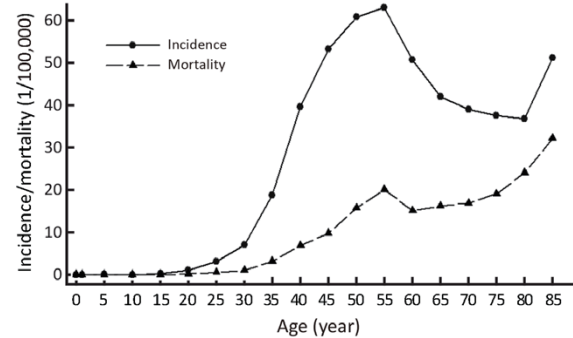

Figure 3 Age-specific incidence and mortality of female breast cancer in Jiangsu province, 2003-2011.

Table 2 Incidence and mortality of female breast cancer in Jiangsu province, 2003-2011

Age groups	Population	Incidence		Mortality	
		Cases	rate (1/10^5)	Deaths	rate (1/10^5)
0–	547,919	0	0.00	0	0.00
1–	2,250,195	0	0.00	0	0.00
5–	3,476,822	0	0.00	0	0.00
10–	4,347,428	0	0.00	0	0.00
15–	4,627,364	11	0.24	0	0.00
20–	5,014,954	55	1.10	9	0.18
25–	5,410,214	165	3.05	28	0.52
30–	6,129,874	435	7.10	63	1.03
35–	6,221,479	1,162	18.68	197	3.17
40–	6,087,461	2,415	39.67	419	6.88
45–	5,603,928	2,980	53.18	549	9.80
50–	4,710,362	2,866	60.84	741	15.73
55–	4,094,635	2,580	63.01	822	20.08
60–	3,237,646	1,643	50.75	488	15.07
65–	2,660,812	1,117	41.98	431	16.20
70–	2,175,191	849	39.03	367	16.87
75–	1,638,321	616	37.60	313	19.10
80–	1,026,784	377	36.72	247	24.06
85+	649,833	333	51.24	209	32.16

the rate of loss to follow-up was 2.5%. The OS and RS from 2003 to 2005 are displayed in *Table 3*. The age-standardized 1-, 3- and 5-year OS was 79.4% [95% confidence interval (95% CI): 76.0–82.9], 58.4% (95% CI: 54.6–62.5) and 45.9% (95% CI: 42.2–49.9), respectively, while RS was 81.4% (95% CI: 77.8–85.1), 62.7% (95% CI: 58.3–67.5) and 52.0% (95% CI: 47.2-57.3), respectively. Both OS and RS were found to be dropped with survival years.

The OS and RS of different ages are also shown in *Table 3*. For each survival year, both OS and RS declined with age. For instance, the 5-year OS of patients at age of 15–44 years was 60.3%, however, the OS dropped to 26.7% for those at age of 75+ years. The RS showed the same pattern, decreased from 60.7% to 40.8%.

The OS and RS in different areas in Jiangsu province are shown in *Table 4*. The lowest survival rates were found in Northern Jiangsu province, where the 5-year OS was 41.0% and RS was 46.8%. On the contrary, the highest survival rates were observed in southern Jiangsu province where the 5-year OS was 53.7% and RS was 62.4%.

Discussion

The incidence and mortality of female breast cancer vary significantly around the world, for instance, in Northern America, the incidence is as high as 76.7/100,000, however, it is only 19.3/100,000 in Eastern Africa (20). The causes to the disparities mentioned above are complex, which have been indicated by previous researches including society, lifestyle, ethnicity, heredity, culture, environment and so on (21-23).

Table 3 OS and RS of female breast cancer in 7 registries of Jiangsu province (patients diagnosed during 2003–2005)

Age groups		Survival (%)				
		1-year	2-year	3-year	4-year	5-year
Crude	OS	84.7 (82.7–86.5)	74.4 (72.1–76.7)	66.2 (63.6–68.6)	60.8 (58.2–63.3)	55.5 (52.9–58.1)
	RS	85.4 (83.4–87.2)	75.7 (73.3–78.0)	67.8 (65.2–70.3)	62.7 (60.0–65.3)	57.7 (54.9–60.4)
Age-standardized	OS	79.4 (76.0–82.9)	67.5 (63.7–71.5)	58.4 (54.6–62.5)	51.7 (48.0–55.8)	45.9 (42.2–49.9)
	RS	81.4 (77.8–85.1)	70.9 (66.7–75.3)	62.7 (58.3–67.5)	57.0 (52.4–62.1)	52.0 (47.2–57.3)
15-44	OS	88.0 (84.2–90.9)	77.0 (72.4–81.0)	69.5 (64.5–73.9)	64.8 (59.6–69.4)	60.3 (55.1–65.1)
	RS	88.1 (84.3–91.0)	77.2 (72.6–81.2)	69.8 (64.7–74.2)	65.1 (59.9–69.8)	60.7 (55.4–65.5)
45-54	OS	86.6 (83.2–89.3)	78.8 (75.0–82.2)	69.8 (65.6–73.7)	64.7 (60.3–68.7)	59.1 (54.6–63.3)
	RS	86.8 (83.5–89.5)	79.3 (75.4–82.6)	70.4 (66.1–74.3)	65.5 (61.0–69.6)	60.1 (55.5–64.4)
55-64	OS	84.2 (79.3–88.0)	72.0 (66.2–76.9)	64.5 (58.5–69.9)	59.7 (53.5–65.2)	54.8 (48.6–60.5)
	RS	84.7 (79.8–88.5)	72.9 (67.0–77.9)	65.8 (59.6–71.3)	61.2 (55.0–67.0)	56.6 (50.3–62.6)
65-74	OS	81.0 (73.8–86.4)	71.1 (63.1–77.6)	64.4 (56.2–71.5)	56.5 (48.2–63.9)	49.1 (41.0–56.8)
	RS	82.2 (74.9–87.7)	73.4 (65.2–80.1)	67.8 (59.2–75.2)	60.7 (51.8–68.7)	54.1 (45.1–62.6)
75+	OS	68.9 (58.2–77.4)	53.3 (42.5–63.0)	40.0 (29.9–49.9)	32.2 (22.9–41.9)	26.7 (18.0–36.1)
	RS	74.0 (62.5–83.1)	61.9 (49.3–73.1)	50.3 (37.6–62.7)	44.5 (31.6–57.9)	40.8 (27.6–55.2)

OS, observed survival; RS, relative survival.

Table 4 Age-standardized OS and RS of female breast cancer by areas in Jiangsu province (7 registries, patients diagnosed 2003–2005)

Survival year	Area	OS (%)	RS (%)
	South Jiangsu	87.1 (75.1–100)	89.0 (76.5–100)
1	Mid-Jiangsu	80.9 (76.9–85.1)	82.8 (78.6–87.2)
	North Jiangsu	74.1 (67.1–81.8)	76.3 (68.9–84.4)
	South Jiangsu	72.5 (58.0–90.7)	76.1 (60.1–96.3)
2	Mid-Jiangsu	70.5 (66.0–75.2)	74.0 (69.1–79.2)
	North Jiangsu	58.6 (51.3–66.8)	61.6 (53.5–70.9)
	South Jiangsu	64.2 (49.5–83.2)	68.8 (51.6–91.9)
3	Mid-Jiangsu	60.6 (56.1–65.6)	65.1 (59.8–70.8)
	North Jiangsu	51.4 (44.5–59.5)	55.4 (47.2–65.0)
	South Jiangsu	57.6 (42.9–77.4)	64.1 (45.7–89.9)
4	Mid-Jiangsu	54.3 (49.7–59.2)	59.7 (54.1–65.8)
	North Jiangsu	44.1 (37.5–51.8)	48.6 (40.4–58.4)
	South Jiangsu	53.7 (38.9–74.0)	62.4 (42.6–91.5)
5	Mid-Jiangsu	47.2 (42.7–52.1)	53.2 (47.5–59.6)
	North Jiangsu	41.0 (34.8–48.4)	46.8 (38.3–57.1)

OS, observed survival; RS, relative survival.

The incidence of breast cancer in Jiangsu province from 2003 to 2011 (ASRC=19.03/100,000) was found slightly lower than the Chinese national average (ASRC=23.27/100,000), and mortality (ASRC=4.93/100,000) was similar with the national level (ASRC=4.93/100,000) (24). Compared to other countries, the incidence of breast cancer in Jiangsu province was slightly above less developed regions, such as Tanzania, Mongolia (25) and Gambia (26), whereas it was below the world average and developed regions, such as America (20), France (27), Japan (28) and Singapore (29). Similarly, the mortality in Jiangsu province was also lower than the international average and some developed regions (2).

Although the incidence and mortality of breast cancer were relatively low in Jiangsu province compared with some regions in the world, they have increased rapidly in recent years. From 2003 to 2011, the age-standardized incidence increased from 10.55/100,000 to 23.39/100,000 and the mortality increased from 3.75/100,000 to 5.27/100,000, which shared the same tendency of China where the age-standardized incidence increased from 22.18/100,000 to 25.89/100,000 and the mortality increased from 4.80/100,000 to 6.56/100,000 during 2004 to 2010 (13,30-32). China has been experiencing the transition in both economy and lifestyle, the development of economy, the acceleration of life pace, the westernization of lifestyle, the decline of fertility and breast feeding among women, the changing of traditional diet structure and significantly increased prevalence in obesity, all of these have jointly contributed to the sharp increase of breast cancer risk in Jiangsu province as well as the whole China (33-35, 22).

Historical data about survival of female breast cancer in China were insufficient. According to limited published results, the total 5-year RS in China in 2003-2005 was estimated to be 73.0%, 77.8% in urban and 55.9% in rural areas (7). The 5-year RS in Jiangsu province was 52.0%, which was similar to the average level in rural areas of China, which could be explained by the fact that most areas selected for survival analysis were rural in the present research. The survival rate of breast cancer varies around the world. In comparison with other countries or regions, the 5-year RS of female breast cancer in Jiangsu province was lower than that of developed regions, such as Germany (36,37), France (38), Korea (39), United States (40), Japan (41), Canada (42,43), but was higher than less developed regions such as Philippines (44), Mumbai, India (43), Gambia (44), Kampala and Uganda (45). Even in China, regional disparities do exist (7). Xiang reported that the 1-, 3- and 5-year RS in Shanghai from 1988 to 1991 was 89.7%, 77.2% and 71.7% (10), respectively. The 5-year RS in Beijing was reported as 66.3% and 74.2% during 1982-1983 and 1987-1988, respectively (9). In Qidong, 1-, 3- and 5-year RS was 84.8%, 70.4% and 63.1% from 1972 to 2011, respectively (12). The factors contributed to such variances between regions and countries are multiple, and some studies indicated that socio-

economic inequalities, type of health insurance and race may affect cancer survival rate. The survival rates of patients in prosperous regions were higher than those in poverty-stricken regions. Moreover, patients who have private insurance had higher survival than other patients (46-48). Besides, variations in the prevalence of associated risk factors, public awareness of health knowledge, environmental pollution, and differences in initial treatment, supervision and support networks may be other reasons of the geographic changes (7). In this study, the difference among survival in south, middle and north Jiangsu province also supported that economic, social determinants and lifestyle may be significant influencing factors of survival rates (49,50).

In this study, the highest 5-year RS was observed among the group of age 15-44 years and the lowest 5-year RS was observed at age of 75+ years. Elderly patients are usually in poor physical condition and may also suffer from other diseases, and thus are prone to receive more conservative treatments (40). Besides, people in this age may also lack of exercise, and previous research had shown that more physical activity did contribute to the decline of breast cancer-specific mortality as well as all-cause mortality (51). These reasons might explain why the survival rate of female breast cancer declines with age.

Early detection of breast cancer is of utmost importance to increase survival rate and reduce mortality rate. Hayat *et al*. (52) found that 5-year RS detected at early stage (stage I) was much higher than those detected at late stage (stage IV). But it is unfortunate that China has no nationwide screening program for breast cancer and earlier-stage detection (53). Therefore, more resources should be allocated to primary prevention and earlier diagnosis, such as screening practices, particularly mammography screening which is more widely used in Western countries. Moreover, public awareness of the benefits of mammography and clinical breast examination in earlier-stage detection should be improved. In addition, more accessible health services should be provided for Chinese women in order to increase the enthusiasm of screening.

Limitations also existed in this study. Firstly, most cancer registries in Jiangsu province were rural areas before 2006, therefore the differences in incidence, mortality and cancer survival between rural and urban areas could not be compared. Secondly, because lacking of historical data, the long-term variations of survival rates in Jiangsu province could not be analyzed yet. Lastly, detailed information of cancer cases, such as cancer stage and histological type, were incomplete in most registries, and thus we were not able to further analyze the association between survival rates and disease (54).

Conclusions

Breast cancer has increased rapidly among Chinese women but the survival is still relatively low especially among rural areas in China. In order to reduce the burden of this disease, more resources should be allocated to primary prevention and earlier diagnosis, and more accessible health services should be provided in order to increase the positivity of screening among Chinese women.

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Footnote

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