Analysis of Breast Cancer Cases According to County-Level Poverty Status in 3.5 Million Rural Women Who Participated in a Breast Cancer Screening Program of Hunan Province, China from 2016–2018

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Abstract

Purpose Thus far there has been no study on the breast cancer screening program in China, especially one exploring differences between poor and non-poor areas. Therefore, we aimed to assessment the effectiveness of the population-based breast cancer screening programs, and clinical epidemiological characteristics of breast cancers in poor and non-poor counties in rural areas of Hunan province from 2016–2018.

Methods 3,151,679 rural women took part in the screening program and 1,169 breast cancer cases was identified. Chi-square and Fisher's exact tests, and binary logistic regression analysis were used for analyzing the difference in risk factors, clinical examination results, and clinicopathological features of breast cancer patients in poor counties compared with those in non-poor counties in rural areas of Hunan province.

Results The breast cancer incidence was $37.09/10^5$. Breast cancer incidence was lower in poor counties ($29.68/10^5$) than in non-poor counties ($43.13/10^5$). There were differences between breast cancers in poor counties and non-poor counties in cyst, margin, internal echo, and blood flow in solid masses in the right breast in ultrasonic examination, lump structure in mammography examination, and clinicopathological staging and grading in pathological examination. Breast cancer in poor counties was more likely to be diagnosed at later stages as determined from the classification in ultrasonic, mammography and pathological examination. Furthermore, indexes of the breast screening program including early detection, incidence, pathological examination, and mammography examination were reduced in poor compared with non-poor counties. Binary logistic regression analysis showed that education, ethnicity, reproductive history and the year 2017 were associated with an increased risk of breast cancer in poor counties (OR >1, $P < 0.05$).

Conclusions Women in poor areas were more likely to be diagnosed at a later breast cancer stage than those in non-poor areas, and therefore, women should have better access to diagnostic and clinical services in poor areas in Hunan province to help rectify this situation.

Introduction

Breast cancer is the most frequently diagnosed cancer and the second leading cause of cancer-related deaths in women worldwide[1,2]. It is estimated that over 508,000 women die from breast cancer each year globally and approximately 58% of those live in low- and middle-income countries. Breast cancer is now the most common cancer in Chinese women and the incidence has increased by 3–5% annually in China for the last 20 years, much faster than the world average annual increase of 0.5%[3]. Noteworthy, breast cancer incidence and mortality rates among Chinese women in rural areas during the last 10 years have been increasing rapidly[4]. The incidence and mortality rates of breast cancer in the eastern and middle areas were similar and higher than those in western areas of China[5]. It was estimated that the age-standardized death rate of breast cancer among women in Hunan province in 2013 was $7.3/10^5$, which was higher than the average of $6.7/10^5$ in China[6].

China has undergone significant development and remarkable change in its social economy that has resulted in a shift from a predominately rural lifestyle to a more Western/urban style over the past decades[7]. The risk factors of breast cancer are prevalent and include early menarche, late menopause, nulliparity, and absence of a history of breastfeeding[8]. The incidence and mortality of breast cancer in China will continue to increase in the future, and in particular, the rate of disease and death will rise significantly faster in rural than in urban areas[9]. Individuals living in poorer areas are less likely to seek cancer screening compared with individuals living in wealthier areas because of the lack of diagnostic and screening opportunities throughout rural areas[10]. Furthermore, women in poor areas are more likely to be diagnosed at later breast cancer stages than those in more affluent areas[11,12]. Breast cancer screening programs are mostly located in upper-middle and high income countries, while breast cancer screening programs are unlikely to be found in low-income and lower-middle income countries[13,14]. Therefore, it is necessary to carry out population-based breast cancer screening in poor areas[15]. To date, nationwide breast cancer population screening has never been implemented in China because of the difficulties associated with large-scale screening programs. As yet, there is no large-scale, geographically representative study of breast cancer screening among the general population. However, Hunan province has organized a population-based breast cancer screening program in rural areas from 2016–2018 with government support.

This study explored the influence of economics on population-based breast cancer screening programs and clinical epidemiological characteristics of breast cancer in poor and non-poor counties in rural areas of Hunan province, China, from 2016–2018. We also provided policy suggestions for improving breast cancer screening programs, improving health, and alleviating poverty in rural areas in the future.

Patients And Methods

Study patients and study design

This study was based on breast screening programs in Hunan province, China, which were required to carry out breast screening for at least one million rural women each year from 2016–2018. Inclusion criteria were: 1) age between 35–64 years; 2) never been diagnosed with breast cancer; 3) rural registered women; 4) voluntarily amenable to undergo breast screening; and 5) not pregnant at the time of enrollment. Exclusion criteria were: 1) pregnant women; 2) refusal to participate; 3) a history of breast cancer; 4) difficulty in obtaining information from the woman; and 5) not locally registered rural women. All the subjects were familiar with the purpose and procedures of the breast screening program and signed informed consent forms to participate in the study. All study protocols were approved by the Ethics Committee of the Hunan Provincial Maternal and Children Health Care Hospital.

Screening protocols and procedures

Trained investigators registered subjects and obtained basic information such as age, education, ethnicity, menstrual history, family history, and fertility history. Subjects then had their clinical breast examination and breast ultrasonography (BUS). In the ultrasound, the physician scanned each quadrant of the breast using the radiating and crossing method at the center of the nipple and completed the ultrasound examination and diagnosis report for each subject.

Subjects with positive and suspected positive results of BUS received mammography (MAM). Those who were MAM-positive or suspected of being positive were subjected to further pathological examination. Upon pathological examination, subjects who were found to be positive were recalled for treatment and followed in the clinic. A schematic of the screening process is shown in Fig. 1.

Data collection

We collected breast cancer screening information from China's major public health service projects' direct reporting system. We obtained quarterly report data on the breast cancer screening program in the rural areas of Hunan province in China from 2016–2018. Data in the quarterly report included the yearly checkup information, the results of BUS, MAM, and pathological examination, as well as the tumor, node, and metastasis (TNM) stage. We obtained information on breast cancer cases in the system, including basic and clinical information, results of BUS, MAM, and pathological examination, and TNM stage and grade.

Hunan province is located in central China, covers 21.18 km^2, and has a population of 71.47 million people, with 90 counties in rural and 33 in urban areas[16]. There are 51 poor counties and 39 non-poor counties in rural areas. The list of poor and non-poor counties was also stipulated by the provincial government. The system was established in 2009 and has now expanded to cover all 90 counties in rural areas in the entire province from 2016.

Data quality control

In order to ensure data accuracy, the information system was subjected to four audit levels: county, prefectural, provincial, and national. The county level unit submitting the original data was responsible for the examination, verification, and modification of the data after it had received all suggestions made during the initial review. The health administration departments at the prefectural, provincial, and national levels were subsequently responsible for reviewing the reported data.

Statistical analyses

Statistical analyses were performed using SPSS 20.0 software. Differences in the basic information, results of BUS, MAM, and pathological examination, and differences in treatment between breast cancer patients in poor and non-poor counties were analyzed using chi-square and Fisher's exact tests. Binary logistic regression analyses were performed to assess the risk factors of breast cancer patients in poor counties. All statistical tests were considered significant when $P < 0.05$.

Results

Comparison of the breast cancer screening program

Comparison of the breast cancer screening programs in non-poor and poor counties is summarized in Table 1. There were 3,151,679 rural women who were screened for breast cancer. There were a total of 82,333 women who were found to be 0-grade and 3-grade in the BUS examination. The total number of women who underwent MMA was 62,577, which was 76% of all women who were found to be 0-grade or 3-grade in BUS examination. The proportion of women who underwent a histopathological examination in non-poor and poor counties was 79.60% and 63.60%, respectively. The total number of breast cancer cases was 1,169. The total number of women given an early diagnosis of breast cancer was 601. The incidence of breast cancer in non-poor and poor counties was $43.13/10^5$ and $29.68/10^5$, respectively.

Table 1

Comparison the evaluation indicators in the breast population screening population between poor and non-poor counties.

Variables	Non-poverty counties	Poverty counties	Total
The total checks	1736684	1414995	3151679
BUS			
The checks	1725041	1414046	3139087
0-grade	11453	3056	14509
1-grade	1184113	1065950	2250063
2-grade	485113	313281	798394
3-grade	38826	28998	67824
4-grade	5376	2669	8045
5-grade	160	92	252
MAM			
The checks	36277	26300	62577
0-grade	898	983	1881
1-grade	7810	5804	13614
2-grade	14209	10239	24448
3-grade	11885	8247	20132
4-grade	1397	985	2382
5-grade	78	42	120
Histopathological examination			
The NO. to be verified	6607	3753	10360
The checks	5259	2387	7646
Dysplasia	58	30	88
Lobular carcinoma in situ	6	17	23
Ductal carcinoma in situ	48	44	92
Invasive ductal carcinoma	617	322	939
Invasive lobular carcinoma	67	42	109
Other types	13	11	24
TNM staging			
The NO. to be verified	697	372	1069
The NO. to be obtained	621	296	917
0-staging	17	11	28
I-staging	143	75	218

**The classification of BUS and MAM is based on the Breast Imaging Reporting And Data System (BI-RADS). The criteria for grading the BUS and MAM results as follows:
0-grade: Incomplete assessment. Further imaging evaluation and comparison with previous findings is required.
1-grade: Negative. The Positive Predictive Value (PPV) is almost zero
2-grade: Benign. The PPV is almost zero.
3-grade: Benign is more likely. The PPV is between 0% and 2%.
4-grade: Maybe malignant. The PPV is between 2% and 95%.
5-grade: Almost malignant. The PPV is between 95% and 100%.
** The TNM grades refer to specific stages of pathological or clinical stages. Priority should be given to pathological staging, if no pathological stages obtained, the clinical stages were filled in.
TNM staging of 0-staging, I-staging and Ⅱa-staging represents the early diagnosis of breast cancer.

Variables	Non-poverty counties	Poverty counties	Total
a-staging	251	104	355
b-staging	108	43	151
≥-staging	102	63	165
The NO. of follow-up	806	464	1270
The NO. of treatment	800	453	1253
Statistical indicators			
The No. of precancerous lesions and breast cancer	796	455	1251
The No. of breast cancer	749	420	1169
The No. of early diagnosis of breast cancer	411	190	601
Breast cancer incidence ($/10^5$)	43.13	29.68	37.09
Early detection proportion of breast cancer (%)	66.18	64.19	65.54
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5-grade: Almost malignant. The PPV is between 95% and 100%.			
** The TNM grades refer to specific stages of pathological or clinical stages. Priority should be given to pathological staging, if no pathological stages obtained, the clinical stages were filled in.			
TNM staging of 0-staging, I-staging and a-staging represents the early diagnosis of breast cancer.			

Comparison of basic and clinical information

Basic and clinical information are shown in Table 2. Breast cancer cases in poor counties increased in 2017 (N = 181, 43.10% vs. N = 255, 34.05%, P = 0.003). Breast cancer patients in non-poor and poor counties mainly received middle high school (N = 336, 44.86%) and primary school educations (N = 205, 48.84%), respectively. The proportion of breast cancer patients of Han ethnicity was lower in poor than in non-poor counties (N = 310, 73.81% vs. N = 682, 91.05%, P < 0.001, respectively). Most of the breast cancer patients in the two groups experienced menarche at 13–14 years of age (N = 406, 54.21% vs. N = 231, 55.00%, P = 0.046). The proportion of breast cancer patients with a reproductive history was lower in poor than in non-poor counties (N = 414, 55.27% vs. N = 741, 98.93%, P = 0.04). However, there were no significant differences between breast cancer patients in the two groups with respect to age, age at menarche, breastfeeding history, surgical history, hormone replacement history, and family history.

Table 2

Comparison of basic and clinical information among female breast cancer cases between poor and non-poor counties.

Variables		Non-poverty counties		Poverty counties		χ^2	p
		N	%	N	%		
Year	2016	186	24.83	104	24.76	11.634	0.003
	2017	255	34.05	181	43.10		
	2018	308	41.12	135	32.14		
Age	35–40	58	7.74	37	8.81	3.977	0.553
	41–45	110	14.69	68	16.19		
	46–50	232	30.97	108	25.71		
	51–55	188	25.10	113	26.90		
	56–60	92	12.28	51	12.14		
	≥61	69	9.21	43	10.24		
Education	≥Junior College	11	1.47	8	1.90	68.105	< 0.001
	High school	172	22.96	40	9.52		
	Middle high school	336	44.86	151	35.95		
	Primary school	204	27.24	205	48.81		
	Missing data	26	3.47	16	3.81		
Ethnicity	Han	682	91.05	310	73.81	129.49	< 0.001
	Others	12	1.60	90	21.43		
	Missing data	55	7.34	20	4.76		
Age at menarche	< 13	133	17.76	61	14.52	7.988	0.046
	13–14	406	54.21	231	55.00		
	15–16	156	20.83	104	24.76		
	> 16	20	2.67	22	5.24		
	Missing data	34	4.54	2	0.48		
Reproductive history	Yes	741	98.93	414	98.57	4.211	0.04
	No	1	0.13	4	0.95		
	Missing data	7	0.93	2	0.48		
Age at fertility	18–21	261	34.85	162	21.63	3.578	0.311
	22–25	416	55.54	224	29.91		
	26–29	33	4.41	28	3.74		
	≥30	4	0.53	3	0.40		
	Missing data	35	4.67	3	0.40		
Menopause	Yes	384	51.27	227	54.05	0.772	0.38
	No	358	47.80	190	45.24		
	Missing data	7	0.93	3	0.71		
Breastfeeding history	Yes	682	91.05	369	87.86	3.848	0.05
	No	61	8.14	49	11.67		
	Missing data	6	0.80	2	0.48		
Surgery history	No	712	95.06	401	95.48	0.008	0.931
	Yes	31	4.14	17	4.05		
	Missing data	37	4.94	2	0.48		
Hormone replacement history	No	727	97.06	413	98.33	1.38	0.24
	Yes	16	2.14	5	1.19		

	Missing data	22	2.94	2	0.48		
Family history	No	718	95.86	407	96.90	0.479	0.489
	Yes	25	3.34	11	2.62		
	Missing data	6	0.80	2	0.48		

Comparison of BUS results

Table 3 shows significant differences in the aspect ratio and edge of the solid mass in the left breast and cyst, the edge of the solid mass and the internal echo and blood flow of the solid mass in the right breast. Breast cancers in poor counties were more likely to have an aspect ratio of a solid tumor of more than 1 (N = 94, 40.17% vs. N = 162, 37.85%, P = 0.039) and an unclear edge of the solid mass in the left breast (N = 141, 60.26% vs. N = 232, 54.21%, P = 0.028). Conversely, cancers in non-poor counties were less likely to have a complicated cyst (N = 18, 2.00% vs. N = 15, 4.29%, P = 0.016) in the right breast. Moreover, the proportion of cancers without blood flow in the solid mass (N = 156, 36.19% vs. N = 51, 21.61%, P < 0.001) and with a clear edge of the solid mass (N = 140, 32.48% vs. N = 53, 22.46%, P = 0.02) in the right breast was higher in non-poor counties. On the whole, women with breast cancer in non-poor counties were encouraged to undergo a pathological examination compared with those in poor counties (N = 444, 59.28% vs. N = 203, 48.33%, P < 0.001, respectively). In a word, BUS examination results showed that there were differences in the cyst, margin, internal echo, and blood flow in the solid mass in the right breast. Women with breast cancer in poor counties were examined and found to have complex cysts, unclear edges, high internal echoes, an aspect ratio of the solid mass of more than 1, and rich blood flow to the solid mass.

Table 3

Comparison of BUS results among female breast cancer cases between and non-poor counties.

Variables		Left						Right					
		Non-poverty counties		Poverty counties		χ^2	P	Non-poverty counties		Poverty counties		χ^2	P
		N	%	N	%			N	%	N	%		
Cyst	None	615	82.11	332	79.05	1.52	0.468	594	79.31	311	74.05	8.23	0.016
	Simple cysts	58	7.74	31	7.38			61	8.14	22	5.24		
	Complicated cysts	18	2.40	15	3.57			15	2.00	18	4.29		
	Missing data	58	7.74	42	10.00			79	10.55	69	16.43		
	Total	749	100.00	420	100.00			749	100.00	420	100.00		
Solid mass	None	321	42.86	186	44.29	2.124	0.346	318	42.46	184	43.81	0.253	0.881
	Single	346	46.19	179	42.62			323	43.12	179	42.62		
	Multiple	52	6.94	37	8.81			50	6.68	31	7.38		
	Missing data	30	4.01	18	4.29			58	7.74	26	6.19		
	Total	749	100.00	420	100.00			749	100.00	420	100.00		
Solid mass - morphology	Round	23	5.37	13	5.56	6.086	0.108	20	4.64	12	5.08	1.347	0.718
	Oval	126	29.44	49	20.94			103	23.90	45	19.07		
	Irregular	209	48.83	128	54.70			208	48.26	111	47.03		
	Lobulated	18	4.21	6	2.56			16	3.71	10	4.24		
	Missing data	52	12.15	38	16.24			84	19.49	58	24.58		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass -aspect ratio	▯1	179	41.82	70	29.91	4.264	0.039	164	38.05	76	32.20	0.005	0.943
	≥ 1	162	37.85	94	40.17			166	38.52	78	33.05		
	Missing data	87	20.33	70	29.91			101	23.43	82	34.75		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass -border	Echo halo ring	107	25.00	59	25.21	1.264	0.261	108	25.06	55	23.31	0.807	0.369
	Sharp	210	49.07	92	39.32			197	45.71	83	35.17		
	Missing data	111	25.93	83	35.47			126	29.23	98	41.53		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass -edge	Clear	140	32.71	56	23.93	4.836	0.028	140	32.48	53	22.46	5.451	0.02
	Non-clear	232	54.21	141	60.26			207	48.03	124	52.54		
	Missing data	56	13.08	37	15.81			84	19.49	59	25.00		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass -internal echo	Uniform	19	4.44	11	4.70	1.99	0.738	14	3.25	15	6.36	14.38	0.006
	Uneven	166	38.79	95	40.60			139	32.25	81	34.32		
	Low	174	40.65	78	33.33			185	42.92	69	29.24		
	Deng	7	1.64	3	1.28			7	1.62	3	1.27		

*The classification of BUS is based on the Breast Imaging Reporting And Data System (BI-RADS). The criteria for grading the BUS results as follows:

0-grade: Incomplete assessment. Further imaging evaluation and comparison with previous findings is required.

1-grade: Negative. The Positive Predictive Value (PPV) is almost zero

2-grade: Benign. The PPV is almost zero.

3-grade: Benign is more likely. The PPV is between 0% and 2%.

4-grade: Maybe malignant. The PPV is between 2% and 95%.

5-grade: Almost malignant. The PPV is between 95% and 100%.

	High	17	3.97	10	4.27			10	2.32	12	5.08		
	Missing data	45	10.51	37	15.81			76	17.63	56	23.73		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass -rear echo	No change	143	33.41	85	36.32	7.67	0.053	187	43.39	83	35.17	5.73	0.126
	Attenuation	98	22.90	51	21.79			14	3.25	15	6.36		
	Enhancement	54	12.62	27	11.54			87	20.19	44	18.64		
	Lateral acoustic shadow	8	1.87	14	5.98			40	9.28	16	6.78		
	Missing data	125	29.21	57	24.36			103	23.90	78	33.05		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass - calcifications	No	186	43.46	86	36.75	3.927	0.14	177	41.07	95	40.25	2.361	0.307
	Tiny	111	25.93	52	22.22			99	22.97	38	16.10		
	Thick	61	14.25	44	18.80			61	14.15	33	13.98		
	Missing data	70	16.36	52	22.22			94	21.81	70	29.66		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Solid mass-blood flow	No	153	35.75	74	31.62	1.313	0.519	156	36.19	51	21.61	16.79	< 0.001
	Little	137	32.01	70	29.91			123	28.54	75	31.78		
	Rich	73	17.06	46	19.66			59	13.69	51	21.61		
	Missing data	65	15.19	44	18.80			93	21.58	59	25.00		
	Total	428	100.00	234	100.00			431	100.00	236	100.00		
Classification	0	16	2.14	7	1.67	6.956	0.224	15	2.00	9	2.14	8.22	0.145
	1	199	26.57	109	25.95			214	28.57	104	24.76		
	2	59	7.88	46	10.95			57	7.61	38	9.05		
	3	109	14.55	73	17.38			104	13.89	70	16.67		
	4	235	31.38	112	26.67			243	32.44	114	27.14		
	5	50	6.68	24	5.71			28	3.74	24	5.71		
	Missing data	81	10.81	49	11.67			88	11.75	61	14.52		
	Total	749	100.00	420	100.00			749	100.00	420	100.00		
	Missing data	19	2.54	18	4.29								
	Total	749	100.00	420	100.00								
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Comparison of MAM results

We found that breast cancers in poor counties were more likely to have a structural disorder in the solid mass in both the left (N = 54, 25.35% vs. N = 85, 23.61%, P = 0.006) and right breast (N = 48, 22.54% vs. N = 68, 18.89%, P = 0.045), and to follow-up with a pathological examination (N = 201, 47.86% vs. N = 323, 43.12%, P = 0.022) (Table 4). In a word, breast cancers of women in poor counties were larger as judged by the MAM results of the two breasts.

Table 4

Comparison of MAM results among female breast cancer cases between poor and non-poor counties.

Variables		Non-poverty counties		Poverty counties		χ^2	p						
		N	%	N	%								
X-ray examination	No	389	51.94	207	49.29	0.756	0.385						
	Yes	360	48.06	213	50.71								
	Total	749	100.00	420	100.00								
Variables		Left				χ^2	p	Right				χ^2	p
		Non-poverty counties		Poverty counties				Non-poverty counties		Poverty counties			
		N	%	N	%			N	%	N	%		
Classification	0	4	1.11	3	1.41	2.877	0.719	8	2.22	3	1.41	3.257	0.661
	1	65	18.06	38	17.84			72	20.00	48	22.54		
	2	55	15.28	36	16.90			62	17.22	37	17.37		
	3	47	13.06	22	10.33			55	15.28	26	12.21		
	4	133	36.94	78	36.62			136	37.78	82	38.50		
	5	26	7.22	9	4.23			19	5.28	17	7.98		
	Missing data	30	8.33	27	12.68			8	2.22	0	0.00		
	Total	360	100.00	213	100.00			360	100.00	213	100.00		
Solid mass	No	130	36.11	77	36.15	0.295	0.587	140	38.89	82	38.50	0.037	0.847
	Yes	178	49.44	95	44.60			158	43.89	96	45.07		
	Missing data	52	14.44	41	19.25			62	17.22	35	16.43		
	Total	360	100.00	213	100.00			360	100.00	213	100.00		
Solid mass -Suspected calcification	No	80	22.22	36	16.90	0.004	0.951	74	20.56	40	18.78	0.329	0.566
	Yes	83	23.06	38	17.84			72	20.00	33	15.49		
	Missing data	197	54.72	139	65.26			214	59.44	140	65.73		
	Total	360	100.00	213	100.00			360	100.00	213	100.00		
Solid mass -structure disorder	No	78	21.67	22	10.33	7.613	0.006	71	19.72	28	13.15	4.009	0.045
	Yes	85	23.61	54	25.35			68	18.89	48	22.54		
	Missing data	197	54.72	137	64.32			221	61.39	137	64.32		
	Total	360	100.00	213	100.00			360	100.00	213	100.00		
Solid mass site	The central	13	3.61	11	5.16	5.711	0.222	7	1.94	5	2.35	3.562	0.469
	Up inside	7	1.94	0	0.00			7	1.94	1	0.47		

*analyzed using Fisher’s exact test.

The classification of MAM is based on the Breast Imaging Reporting And Data System (BI-RADS). The criteria for grading the MAM results as follows:

0-grade: Incomplete assessment. Further imaging evaluation and comparison with previous findings is required.

1-grade: Negative. The Positive Predictive Value (PPV) is almost zero

2-grade: Benign. The PPV is almost zero.

3-grade: Benign is more likely. The PPV is between 0% and 2%.

4-grade: Maybe malignant. The PPV is between 2% and 95%.

5-grade: Almost malignant. The PPV is between 95% and 100%.

	Down inside	22	6.11	11	5.16	22	6.11	12	5.63
	Up outside	12	3.33	4	1.88	9	2.50	9	4.23
	Down outside	91	25.28	45	21.13	76	21.11	43	20.19
	Missing data	215	59.72	142	66.67	239	66.39	143	67.14
	Total	360	100.00	213	100.00	360	100.00	213	100.00

*analyzed using Fisher’s exact test.

The classification of MAM is based on the Breast Imaging Reporting And Data System (BI-RADS). The criteria for grading the MAM results as follows:

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4-grade: Maybe malignant. The PPV is between 2% and 95%.

5-grade: Almost malignant. The PPV is between 95% and 100%.

Comparison of pathological examination results

Pathological characteristics are displayed in Table 5. Regarding clinical and pathological staging, breast cancers were staged to a lesser extent in poor counties than in non-poor counties (N = 203, 49.27% vs. N = 484, 65.58%, P < 0.001 and N = 187, 45.39% vs. N = 439, 59.49%, P < 0.001, respectively). Breast cancers in non-poor counties were more likely to be considered as c-TNM clinical staging grade two (N = 282, 59.75%, N = 82, 43.62%, P = 0.008) and p-TNM clinical staging grade two (N = 245, 57.92%, N = 72, 41.62%, P = 0.009). However, breast cancer patients in poor counties were less likely to be treated following a pathological diagnosis (N = 394, 93.81%, N = 713, 95.19%, P = 0.026). Breast cancer cases in poor counties had a lower proportion of clinical and pathological staging and higher breast cancer rates for those that obtained clinical and pathological staging in both breasts compared with women in non-poor counties.

Table 5

Comparison of pathological examination results among female breast cancer cases between poor and non-poor counties.

Variables		Non-poverty counties		Poverty counties		χ^2	p
		N	%	N	%		
Pathological examination	Yes	738	98.53	412	98.10	0.038	0.846
	No	3	0.40	2	0.48		
	Missing data	8	1.07	6	1.43		
	Total	749	100.00	420	100.00		
Treatment	Yes	713	95.19	394	93.81	4.936	0.026
	No	4	0.53	9	2.14		
	Missing data	32	4.27	17	4.05		
	Total	749	100.00	420	100.00		
Clinical staging	Obtainment	484	65.58	203	49.27	27.887	< 0.001
	Not-obtainment	191	25.88	163	39.56		
	Missing data	63	8.54	46	11.17		
	Total	738	100.00	412	100.00		
c-TNM clinical staging	Yes	472	97.52	188	92.61	0.229	0.633
	No	8	1.65	5	2.46		
	Missing data	4	0.83	10	4.93		
	Total	484	100.00	203	100.00		
c-TNM clinical staging grate	0	4	0.85	1	0.53		0.008*
	1	103	21.82	48	25.53		
	2	282	59.75	82	43.62		
	3	64	13.56	41	21.81		
	4	7	1.48	3	1.60		
	Missing data	12	2.54	13	6.91		
	Total	472	100.00	188	100.00		

Variables		Non-poverty counties		Poverty counties		χ^2
		N	%	N	%	
Classification	Dysplasia	1	0.14	0	0.00	
	Invasive lobular carcinoma	70	9.49	38	9.22	
	Invasive ductal carcinoma	570	77.24	309	75.00	
	Invasive lobular carcinoma and Invasive ductal carcinoma	1	0.14	1	0.24	
	fibrous adenoma	6	0.81	0	0.00	
	Lobular carcinoma in situ	2	0.27	0	0.00	
	Other types	25	3.39	12	2.91	
	Missing data	63	8.54	52	12.62	
	Total	738	100.00	412	100.00	
Pathological staging	Obtainment	439	59.49	187	45.39	15
	Not-obtainment	216	29.27	156	37.86	
	Missing data	83	11.25	69	16.75	
	Total	738	100.00	412	100.00	
p-TNM clinical staging	Yes	423	96.36	173	92.51	0.
	No	10	2.28	6	3.21	
	Missing data	6	1.37	8	4.28	
	Total	439	100.00	187	100.00	
p-TNM clinical staging grate	0	4	0.95	2	1.16	
	1	88	20.80	51	29.48	
	2	245	57.92	72	41.62	
	3	66	15.60	37	21.39	
	4	8	1.89	3	1.73	
	Missing data	12	2.84	8	4.62	
	Total	423	100.00	173	100.00	

*analyzed using Fisher's exact test.

*c-TNM clinical staging grate was made before treatment and obtained by physical diagnosis, imageological diagnosis, pathological biopsy and other means

p-TNM clinical staging grate was made only for definitive surgical and postoperative pathologic inspections, which was based on a combination of clinical s surgical outcome. The meaning of c-TNM clinical staging grate and p-TNM clinical staging grate was based the seventh edition of the cancer staging manua American Joint Committee on Cancer(AJCC).

Binary logistic regression analysis results of risk factors among breast cancer patients in poor counties

Binary logistic regression analysis was performed in 1015 cases after deleting the cases with missing values in the analysis variables. It indicated that the following risk factors were related to breast cancer in poor counties: year (2017 compared with 2016), education, ethnicity and reproductive history (OR > 1, P < 0.05). All results of the binary logistic regression analysis are listed in Table 6.

Tables 6. Binary logistic regression analysis of female breast cancer related factors in poor counties.

Variables	B	S.E,	Wals	df	Sig.	aOR	aOR 95% C.I.	
							Down	Up
Year(Ref. =2016)			12.927	2	0.002			
2017	0.376	0.185	4.150	1	0.042	1.456	1.014	2.091
2018	-0.217	0.188	1.337	1	0.248	0.805	0.556	1.163
Education(Ref. =junior college)			55.901	3	0.000			
High school	-0.817	0.588	1.934	1	0.164	0.442	0.140	1.397
Middle high school	-0.119	0.565	0.044	1	0.833	0.888	0.293	2.685
Primary school	0.711	0.565	1.584	1	0.208	2.035	0.673	6.155
Ethnicity of others(Ref.=Han)	2.674	0.324	67.958	1	0.000	14.494	7.675	27.369
Reproductive history(Ref.=Yes)	0.432	0.167	5.573	1	0.016	1.567	1.086	2.262
constant	-0.907	0.560	2.620	1	0.106	0.404		
*Forward Wald of Binary logistic regression analysis.								
*aOR was adjusted by age, age at menarche, age at fertility, reproductive history, menopause, Breastfeeding history.								

Discussion

To the best of our knowledge, this is the first study analyzing data from the breast cancer screening program in China. In this study, we explored differences related to the effects of implementing the breast cancer screening program and to the clinical examination results between breast cancer patients in poor and non-poor counties in rural areas of Hunan province from 2016–2018. In this study, we found that indexes of the breast screening program including the proportion of breast cancers detected early, the breast cancer incidence, the proportion of breast cancer cases that underwent pathological examination, and the MAM examination rate were lower in poor counties than in non-poor counties. This study indicated that the incidence of breast cancer was lower in poor areas, which was similar with other studies[17 – 19]. The prevalence of breast cancer in rural areas in our study was $37.09/10^5$ in Hunan province, which was higher than the $25.28/10^5$ in rural areas of China in 2010, sourced from a total of 145 population-based cancer registries[5] and the $21.0/10^5$ in rural areas of Jiangsu province based on statistics from eligible cancer registries in Jiangsu in China from 2006–2010[20]. Furthermore, it was lower than that reported in developed countries of $73.4/10^5$, but higher than that in developing countries of $31.3/10^5$, according to global cancer statistics from 2012[21]. In poor rural areas, breast cancer patients were undereducated and menarche occurred at an older age. Worldwide, the incidence of breast cancer increases in parallel with socioeconomic development. There is no doubt that changes in breast cancer risk have taken place in parallel with socioeconomic development and urbanization over the past three decades in China[19]. The allocation of and accessibility to health resources was reduced in poor counties compared with those in non-poor counties, resulting in lower pathological examination and MAM rates. When planning breast screening programs, regional differences in breast cancer incidence and allocation of and accessibility to health resources should be taken into account[22].

In this study, we first found that there were differences in various factors including year, level of education, ethnicity, age at menarche, and reproductive history between breast cancer patients in poor and non-poor counties. Second, binary logistic regression analysis showed that the year (2017 vs. 2016), non-Han ethnicity, education, and reproductive history were associated with an increased risk of breast cancer in poor counties. Since the program was launched in 2016, women with symptoms volunteered to participate in the program in 2017, resulting in an increase in the number of patients with breast cancer detected.

Racial disparity persists in breast screening, such as Hispanic and non-Hispanic white women[22]. In this study, other ethnicities except Han have been found to have a lower education level and socioeconomic status, and reduced access to health care. Age at menarche was one of the breast cancer risk factors[23,24]. Early age at menarche is associated with an increased risk of breast cancer[25]. Western style fast food and high sugar drinks have become more and more popular among children in China. Ma *et al* reported that the age of menarche among healthy urban Chinese girls decreased from 13.5 years in 1979 to 12.27 years between 2003 and 2005[26]. Thereafter, age at menarche (> 13 years compared with < 13 years) was not the risk factor when adjusted all the variables that there were differences in the single logistic regression analysis in our study. Studies over the past several decades have indicated that individuals living in less developed areas often had worse general health compared with individuals living in relatively developed areas[27, 28]. This could also help explain the differences in breast cancer screening results for women in poor counties compared with those in non-poor counties.

Doctors more readily advised women with breast cancer in poor counties to receive pathological examination following BUS and MAM examinations. The proportion of women receiving treatment for breast cancer in poor counties was lower than that for those in non-poor counties. In other words, women with breast cancer in poor counties were found to have a higher rate of malignancy and reduced access to medical services despite the lower incidence of breast cancer in poor compared with non-poor counties. Other similar studies have come to the same conclusion. For example, Williams et al. found that the odds of a late diagnosis among women living in non-metropolitan or rural counties was over 11% higher compared with their metropolitan or urban counterparts, and that black women had a 1.5-fold increased odds of being diagnosed with late-stage breast cancer compared with their white counterparts, despite the fact that black women have a lower incidence of breast cancer than white women[29]. Nguyen-Pham et al. found that rural breast cancer patients had 1.19 higher odds of being diagnosed with late-stage breast cancer compared with urban breast cancer patients[30]. Anderson et al. concluded that a lack of breast cancer screening and living in poorer rural areas were associated with a 3.31 times greater rate of women diagnosed with later stage breast cancer in Appalachia compared with those living in less deprived regions[31, 32]. Although socioeconomic status has been found to be a key determinant of cancer stage at diagnosis in Western countries[33], there was a systematic study on the relationship between socioeconomic status and breast cancer stage at diagnosis in China, which also concluded that women in low socioeconomic status areas were more likely to be diagnosed at a later breast cancer stage than those in higher socioeconomic status areas in China[34, 35]. From our study, it appears that women with breast cancer in poor counties are in need of more diagnostic and clinical than screening services. This finding helps to emphasize the fact that just providing free screening services is not enough to make up for a lack of preventive care for low income and uninsured women[36].

Environmental factors play an important role in the development of cancer and suggest that region-tailored cancer prevention strategies are warranted[37]. For improving breast cancer outcomes in rural areas of China, we suggest providing free screening services that are also supported with more diagnostic and clinical services as a long-term policy of benefiting women in rural areas and ensuring that they be made available in poor areas in Hunan province.

Our study had some limitations. First, we did not investigate some important risk factors such as economic income and body mass index because we obtained the data from the unified national table. Most importantly, we could not analyze and compare the age distribution between poor and non-poor counties to see whether the differences that the breast cancer incidence was lower in poor counties are due to the age distribution because of the data unavailability. Second, there was recall bias regarding the basic information that was obtained for the breast cancer cases. Third, though the whole province had carried out a unified training for all doctors involved in administering BUS, MAM, and pathological examinations, there were differences in the quality of the examinations and information filling. It was also the reason of information missing.

Conclusions

Population-based breast cancer screening programs in rural areas showed that there were differences in the evaluation indicators and clinicopathological characteristics of the breast cancer cases according to the county-level poverty status. Though the incidence of breast cancer was lower in poor than in non-poor counties, women in poor areas were more likely to be diagnosed at later breast cancer stages than those in non-poor areas, and additional diagnostic and clinical services should be provided in poor areas to address these concerns.

Abbreviations

BUS Breast ultrasonography

MAM Mammography

TNM Tumor, Node, and Metastasis

km^2 Square kilometer,

OR Odds ratio

BI-RADS Breast Imaging Reporting And Data System

AJCC American Joint Committee on Cancer

Declarations

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Author contributions

Conceptualization: XLL and WYL. Data curation: XLL, WAH, LHY, LT, WYX, XDH, KFJ , LZY, CHX and FJQ. Formal analysis: XLL and YGH. Methodology: XLL, WYL, LZY, CXH and FJQ. Project administration: XLL, FJQ and CXH. Supervision: FJQ, WYL and LZY. Visualization: XLL and LZY. Writing original draft: XLL. Writing, review & editing: XLL, LZY, WYL, FJQ and CXH.

Compliance with ethical standards

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Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval This article does not contain any studies with animals performed by any of the authors. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study. The study was approved by he Ethics Committee of the Hunan Provincial Maternal and Children Health Care Hospital. (No. 2019-15).

References

1. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D (2011) Global cancer statistics. CA: a cancer journal for clinicians 61 (2):69-90.
2. Ferlay J, Soerjomataram I, Dikshit R, Eser S, Mathers C, Rebelo M, Parkin DM, Forman D, Bray F (2015) Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. International journal of cancer 136 (5):E359-386.
3. Zeng H, Zheng R, Zhang S, Zou X, Chen W (2014) Female breast cancer statistics of 2010 in China: estimates based on data from 145 population-based cancer registries. Journal of thoracic disease 6 (5):466-470.
4. Zheng Y, Chun-Xiao WU, Zhang ML (2013) The epidemic and characteristics of female breast cancer in China. China Oncology 23 (8):561-569.
5. Hongmei Z, Rongshou Z, Siwei Z, Xiaonong Z, Wanqing C (2014) Female breast cancer statistics of 2010 in China: estimates based on data from 145 population-based cancer registries. Journal of thoracic disease 6 (5):466.
6. Zhou M, Wang H, Zhu J, Chen W, Wang L, Liu S, Li Y, Wang L, Liu Y, Yin P (2016) Cause-specific mortality for 240 causes in China during 1990–2013: a systematic subnational analysis for the Global Burden of Disease Study 2013. Lancet 387 (10015):251-272.
7. Song QK, Wang XL, Zhou XN, Yang HB, Li YC, Wu JP, Ren J, Lyerly HK (2015) Breast Cancer Challenges and Screening in China: Lessons From Current Registry Data and Population Screening Studies. Oncologist 20 (7):773-779.
8. Perry CS, Otero JC, Palmer JL, Gross AS (2010) Risk factors for breast cancer in East Asian women relative to women in the West. Asia-pacific Journal of Clinical Oncology 5 (4):219-231.
9. Xj M, Lin C, ., Zhen W, . (2008) Cancer care in China: A general review. Biomedical Imaging & Intervention Journal 4 (3):e39.
10. Breen N, ., Wagener DK, Brown ML, Davis WW, Ballard-Barbash R, . (2001) Progress in cancer screening over a decade: results of cancer screening from the 1987, 1992, and 1998 National Health Interview Surveys. J Natl Cancer Inst 93 (22):1704-1713.
11. Wang Q (2012) Breast cancer stage at diagnosis and area-based socioeconomic status: a multicenter 10-year retrospective clinical epidemiological study in China. Bmc Cancer 12 (1):122.
12. Coughlin SS, Thompson TD, Hall HI, Logan P, Uhler RJ (2010) Breast and cervical carcinoma screening practices among women in rural and nonrural areas of the United States, 1998-1999. Cancer 94 (11):2801-2812.
13. Lu M (2012) A systematic review of interventions to increase breast and cervical cancer screening uptake among Asian women. Bmc Public Health 12 (1):413-413.
14. Islam RM, Billah B, Hossain MN, Oldroyd J (2017) Barriers to Cervical Cancer and Breast Cancer Screening Uptake in Low-Income and Middle-Income Countries: A Systematic Review. Asian Pac J Cancer Prev 18 (7):1751-1763.
15. Coughlin SS, Thompson TD, H Irene H, Pamela L, Uhler RJ (2010) Breast and cervical carcinoma screening practices among women in rural and nonrural areas of the United States, 1998-1999. Cancer 94 (11):2801-2812.
16. Lili X, Jian H, Mengjun Z, Yinglan W, Donghua X, Aihua W, Fanjuan K, Hua W, Zhiyu L, Das JK Epidemiological analysis of maternal deaths in Hunan province in China between 2009 and 2014. PLoS ONE 13 (11).
17. Xufeng F, Jiaping W, Zhe K, George C (2015) Urban-rural disparity of breast cancer and socioeconomic risk factors in China. Plos One 10 (2):e0117572.
18. Huang Y, Dai H, Song F, Li H, Yan Y, Yang Z, Ye Z, Zhang S, Liu H, Cao Y, Xiong L, Luo Y, Pan T, Ma X, Wang J, Song X, Leng L, Zhang Y, Sun J, Wang J, Ma H, Kong L, Lei Z, Wang Y, Peishan W, Han J, Hao X, Chen K (2016) Preliminary effectiveness of breast cancer screening among 1.22 million Chinese females and different cancer patterns between urban and rural women. Scientific reports 6:39459.
19. Wen D, Wen X, Yang Y, Chen Y, Wei L, He Y, Shan B (2018) Urban rural disparity in female breast cancer incidence rate in China and the increasing trend in parallel with socioeconomic development and urbanization in a rural setting. Thoracic cancer 9 (2):262-272. doi:10.1111/1759-7714.12575
20. Li-Zhu W, Ren-Qiang H, Jin-Yi Z, Jie Y, Mei-Hua D, Yun Q, Ming W (2014) Incidence and mortality of female breast cancer in Jiangsu, China. Asian Pac J Cancer Prev 15 (6):2727-2732
21. Torre LA, Bray F, Siegel RL, Ferlay J, Lortet-Tieulent J, Jemal A (2015) Global cancer statistics, 2012. CA: a cancer journal for clinicians 65 (2):87-108.
22. Doescher M, Jackson J (2009) Trends in cervical and breast cancer screening practices among women in rural and urban areas of the United States. Journal of Public Health Management & Practice 15 (3):200-209
23. Jadav S, Rajan SS, Abughosh S, Sansgiry SS (2015) The Role of Socioeconomic Status and Health Care Access in Breast Cancer Screening Compliance Among Hispanics. Journal of Public Health Management & Practice Jphmp 21 (5).
24. Costantino JP, Gail MH, Pee D, Anderson S, Redmond CK, Benichou J, Wieand HS (1999) Validation studies for models projecting the risk of invasive and total breast cancer incidence.

25. Mcdonald JA, Tehranifar P, Flom JD, Terry MB, James-Todd T (2018) Hair product use, age at menarche and mammographic breast density in multiethnic urban women. Environmental Health 17 (1):1.
26. Feng F, Wei Y, Zheng K, Li Y, Zhang L, Wang T, Zhang Y, Li H, Ren G, Li F (2018) Comparison of epidemiological features, clinicopathological features, and treatments between premenopausal and postmenopausal female breast cancer patients in western China: a retrospective multicenter study of 15,389 female patients. Cancer Medicine
27. Ma HM, Du ML, Luo XP, Chen SK, Liu L, Chen RM, Zhu C, Xiong F, Li T, Wang W, Liu GL (2009) Onset of breast and pubic hair development and menses in urban chinese girls. Pediatrics 124 (2):e269-277.
28. Ma HM, Du M-L, Luo X-P, Chen S-K, Liu L, Chen R-M, Zhu C, Xiong F, Li T, Wang W Onset of Breast and Pubic Hair Development and Menses in Urban Chinese Girls. Pediatrics 124 (2):e269-e277.
29. Shepherd CC, Li J, Zubrick SR (2012) Socioeconomic disparities in physical health among Aboriginal and Torres Strait Islander children in Western Australia. Ethnicity & health 17 (5):439-461.
30. Audureau E, Rican S, Coste J (2013) Worsening trends and increasing disparities in health-related quality of life: evidence from two French population-based cross-sectional surveys, 1995-2003. Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation 22 (1):13-26.
31. Williams F, Thompson E (2016) Disparity in Breast Cancer Late Stage at Diagnosis in Missouri: Does Rural Versus Urban Residence Matter? J Racial Ethn Health Disparities 3 (2):233-239
32. Nguyen-Pham S, Leung J, McLaughlin D (2014) Disparities in breast cancer stage at diagnosis in urban and rural adult women: a systematic review and meta-analysis. Annals of epidemiology 24 (3):228-235.
33. Anderson RT, Yang TC, Matthews SA, Camacho F, Kern T, Mackley HB, Kimmick G, Lengerich E, Yao N (2014) Breast Cancer Screening, Area Deprivation, and Later-Stage Breast Cancer in Appalachia: Does Geography Matter? Health Services Research 49 (2):546-567
34. Renna Junior NL, Gae S (2018) Late-Stage Diagnosis of Breast Cancer in Brazil: Analysis of Data from Hospital-Based Cancer Registries (2000-2012). Revista Brasileira De Ginecologia E Obstetrícia 40 (03):127-136
35. Wang Q, Li J, Zheng S, Li JY, Pang Y, Huang R, Zhang BN, Zhang B, Yang HJ, Xie XM (2012) Breast cancer stage at diagnosis and area-based socioeconomic status: a multicenter 10-year retrospective clinical epidemiological study in China. Bmc Cancer 12 (1):122
36. Jerome-D'Emilia B, Kushary D, Burrell SA, Suplee PD, Hansen K (2018) Breast Cancer Stage at Diagnosis in a New Jersey Cancer Education and Early Detection Site. Am J Clin Oncol:1
37. Liu Z, Shi O, Cai N, Jiang Y, Zhang K, Zhu Z, Yuan H, Fang Q, Suo C, Franceschi S, Zhang T, Chen X (2019) Disparities in cancer incidence among Chinese population versus migrants to developed regions: a population based comparative study. Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology.

Figures

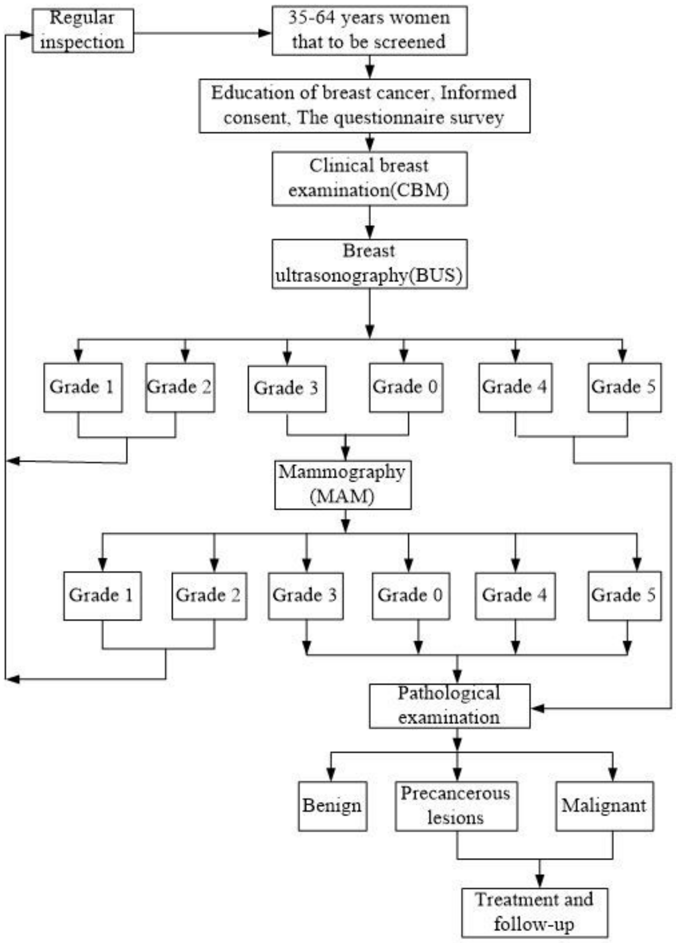

Figure 1

Schematic of the breast cancer screening process followed in Hunan province, China.

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