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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 to 2018

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Abstract

The Hunan provincial government has implemented a free breast cancer screening program for rural women aged 35 to 64 years from 2016, under a 2015 policy aimed at of poverty eradication and improving women's health in China. However, there has been no population study of the breast cancer screening program in China to date, especially considering exploring differences related to the area's poverty status. We explored differences in risk factors, clinical examination results, and clinicopathological features among breast cancer patients in poor compared with non-poor counties in rural areas of Hunan province from 2016 to 2018 using χ^2 and Fisher's exact test, and multivariate logistic regression analysis. A total of 3,151,679 women from rural areas participated in the screening program, and the breast cancer prevalence was 37.09/10^5. Breast cancer prevalence was lower in poor (29.68/10^5) than in non-poor counties (43.13/10^5). There were differences between breast cancers in poor and non-poor counties in terms of cysts, margins, internal echo, blood flow in solid masses in the right breast on ultrasound examination, lump structure in mammograms, and clinicopathological staging and grading in pathological examinations. Breast cancer in poor counties was more likely to be diagnosed at later stages as determined by ultrasound, mammography, and pathological examinations. Furthermore, indexes of the breast screening program including early detection, prevalence, pathological examination, and mammography examination were lower in poor compared with non-poor counties. Multivariate 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 (odds ratio >1, $P<.05$). In conclusion, women in poor areas were more likely to be diagnosed with breast cancer at a later stage compared with women in non-poor areas. Women in poor areas of Hunan province should therefore have better access to diagnostic and clinical services to help rectify this situation.

Abbreviations: BI-RADS = Breast Imaging Reporting And Data System, BUS = Breast ultrasonography, MAM = Mammography, TNM = Tumor, Node, and Metastasis.

Keywords: breast cancer, breast cancer screening, poor area, rural

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1. 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 globally each year and ~58% of those live in low- and middle-income countries. Breast cancer is now the most common cancer in Chinese women, and its incidence in China has increased by 3% to 5% annually for the last 20 years, which is much faster than the average annual global increase of 0.5%.[3] Notably, breast cancer incidence and mortality rates among Chinese women in rural areas have been increasing rapidly during the last 10 years.[4] The incidence and mortality rates of breast cancer in the eastern and middle areas of China are similar to or higher than those in western areas,[5] and the estimated age-standardized death rate due to breast cancer among women in Hunan province in 2013 was 7.3/10,[5] which was higher than the Chinese average of 6.7/10.[5,6]

China has undergone significant development and remarkable change in its social economy, resulting in a shift from a predominately rural lifestyle to a more Western/urban lifestyle over recent decades.[7] The risk factors for breast cancer are prevalent, and include early menarche, late menopause, nulliparity, and no history of breastfeeding.[8] The incidence and mortality of breast cancer in China are thus expected to continue to increase especially in rural rather than 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 with breast cancer at later stages than those in more affluent areas.[11,12] Breast cancer screening programs are mostly applied in upper-middle and high income countries, and are less likely to occur in low-income and lower-middle income countries.[13,14] It is therefore necessary to carry out population-based breast cancer screening in poor areas.[12] No nationwide breast cancer population screening has been implemented in China to date because of difficulties associated with large-scale screening programs, and no large-scale, geographically representative study of breast cancer screening has been conducted among the general population. However, Hunan province organized a population-based breast cancer screening program in rural areas from 2016 to 2018 with government support.

This study explored the influence of economics on population-based breast cancer screening programs and the clinical epidemiological characteristics of breast cancer in poor and non-poor counties in rural areas of Hunan province, China, from 2016 to 2018. The results suggest policy changes aimed at improving breast cancer screening programs, improving health, and alleviating poverty in rural areas of China in the future.

2. Materials and methods

2.1. Subjects 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 women from rural areas each year from 2016 to 2018. The inclusion criteria were:

1. age 35 to 64 years;
2. never diagnosed with breast cancer;
3. rural registered women;
4. voluntarily amenable to undergoing breast screening; and
5. not pregnant at the time of enrollment.

The 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 provided written informed consent for participation in the study. All study protocols were approved by the Ethics Committee of the Hunan Provincial Maternal and Children Health Care Hospital.

2.2. Screening protocols and procedures

Trained investigators registered the subjects and obtained basic information such as age, education, ethnicity, menstrual history, family history, and fertility history. Subjects then underwent clinical breast examination and breast ultrasonography (BUS). During the ultrasound examination, 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 or suspected positive results of BUS received mammography (MAM) and patients who were MAM-positive or suspected positive were subjected to further pathological examination. Patients who were positive upon pathological examination were recalled for treatment and followed in the clinic. A schematic of the screening process is shown in Figure 1.

2.3. 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 to 2018. Data in the quarterly report included 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 has a population of 71.47 million people and covers 21.18 km^2 in central China, including 90 counties in rural and 33 in urban areas.[15] Fifty-one of the rural counties are considered to be poor and 39 as non-poor. The list of poor and non-poor counties was stipulated by the provincial government and the geographical positions are shown in Figure 2. The reporting system was established in 2009 and has expanded to cover all 90 counties in rural areas throughout the entire province from 2016.

2.4. Data quality control

The information system was subjected to four audit levels to ensure data accuracy: 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 receipt of 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.

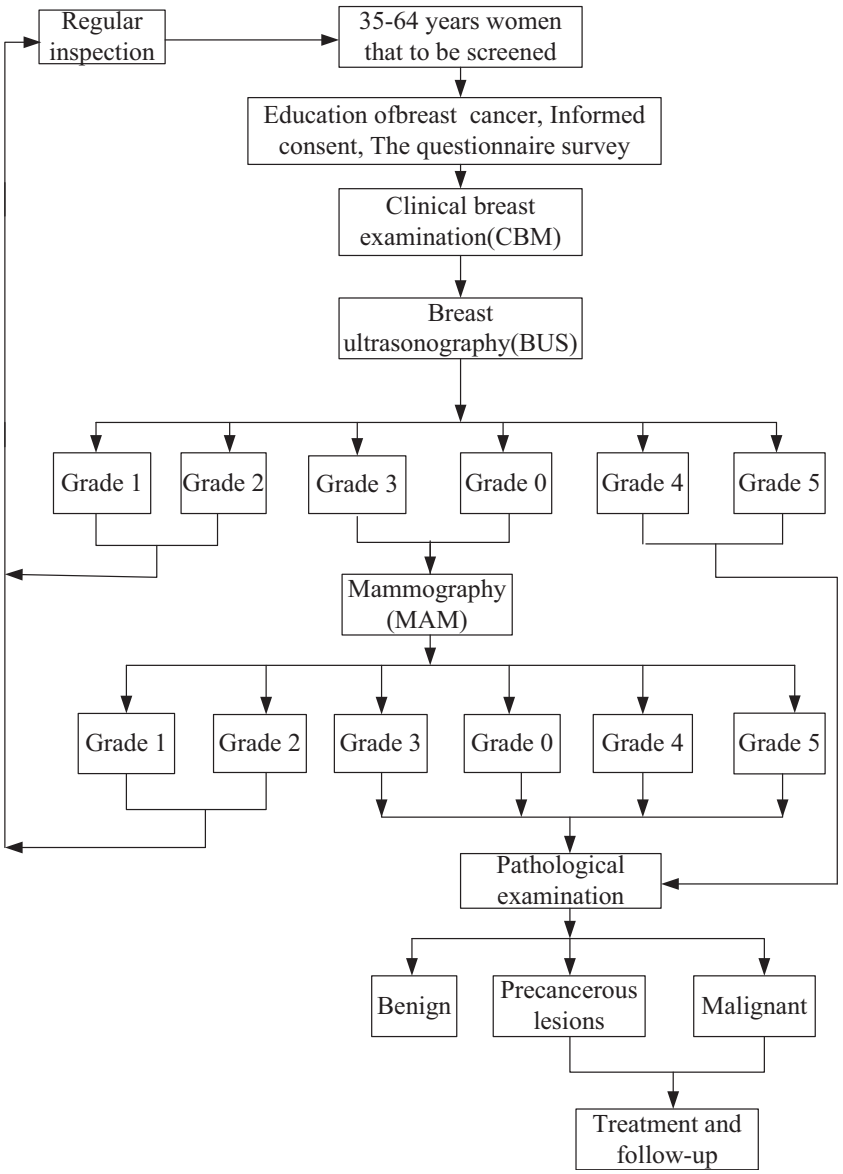

Figure 1. Schematic of the breast cancer screening process followed in Hunan province, China.

2.5. 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 χ^2 and Fisher's exact tests. Multivariate logistic regression analyses were performed to assess the risk factors of breast cancer patients in poor counties. All statistical tests were considered significant when $P < .05$.

3. Results

3.1. Comparison of breast cancer screening program in relation to county poverty level

Comparison of the breast cancer screening programs in non-poor and poor counties was summarized in Table 1. A total of 3,151,679 women from rural areas were screened for breast cancer, of whom 82,333 women were found to be 0-grade and 3-grade by BUS examination. A total of 62,577 women underwent MAM, accounting for 76% of all women who were 0-grade or 3-grade by BUS examination. The proportions of women in non-poor and poor counties who underwent histopathological examination in were 79.60% and 63.60%, respectively. The total number of breast cancer cases was 1,169 and 601 women received an early diagnosis of breast cancer. The prevalence of breast cancer in non-poor and poor counties were $43.13/10^5$ and $29.68/10^5$, respectively.

3.2. Comparison of basic and clinical information in relation to county poverty level

Basic and clinical information are shown in Table 2. The number of breast cancer cases in poor counties increased in 2017 compared with 2016 (N = 181, 43.10% vs N = 255, 34.05%, $P = .003$). The median age of women diagnosed with breast

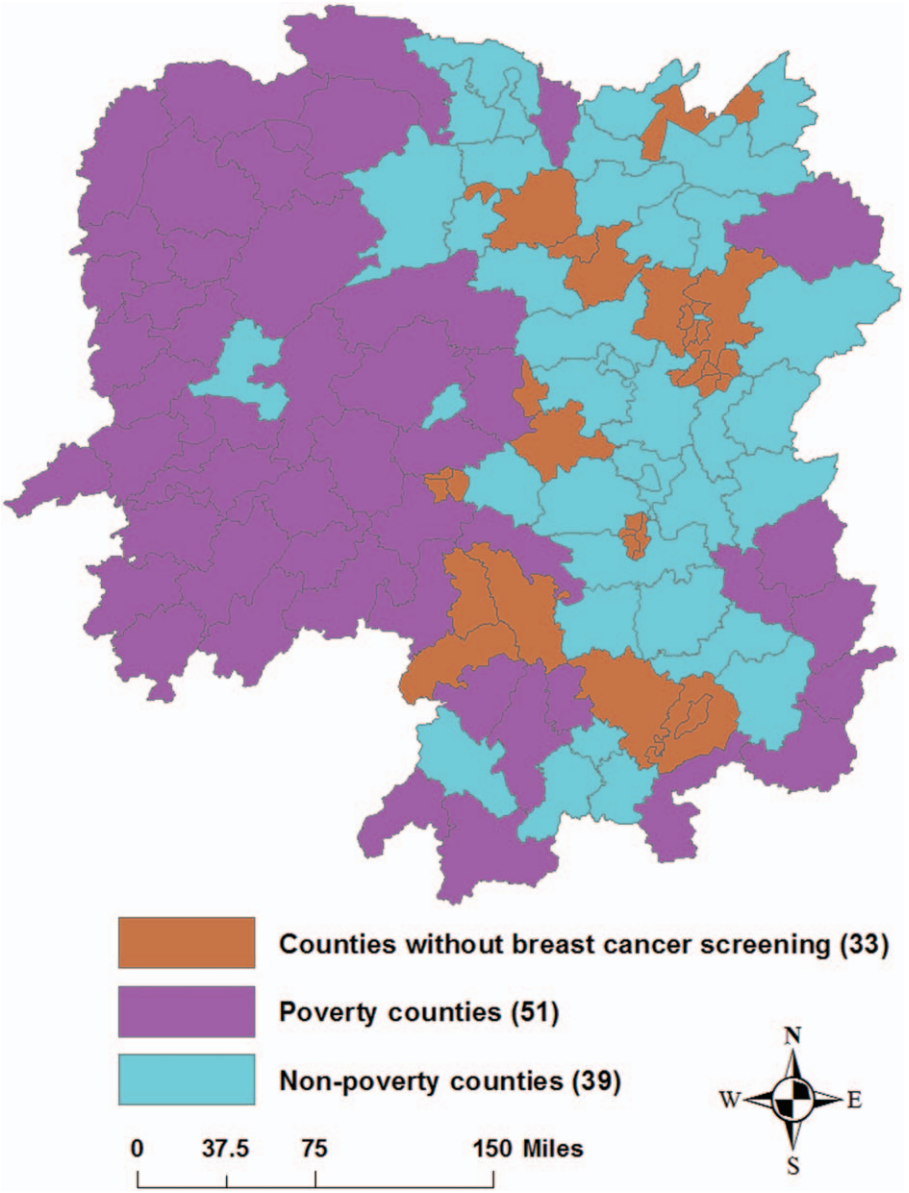

Figure 2. Geographical position of breast cancer screening counties in Hunan province, China.

cancers was 50 years in both poor and non-poor counties. 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 significantly lower in poor compared with non-poor counties (N=310, 73.81% vs N=682, 91.05%, $P<.001$, respectively). Most breast cancer patients in both groups experienced menarche at 13 to 14 years of age (N=406, 54.21% vs N=231, 55.00%, $P=.046$). The proportion of breast cancer patients with a reproductive history was significantly lower in poor compared with non-poor counties (N=414, 55.27% vs N=741, 98.93%, $P=.04$). 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.

3.3. Comparison of BUS results in relation to county poverty level

There were 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 between the two groups (Table 3). Breast cancers in women in poor counties were significantly more likely to have a solid tumor aspect ratio >1 (N=94, 40.17% vs N=162, 37.85%, $P=.039$) and an unclear edge of the solid mass in the left breast (N=141, 60.26% vs N=232, 54.21%, $P=.028$). Conversely, cancers in women from non-poor counties were significantly less likely to have a complicated cyst (N=18, 2.00% vs N=15, 4.29%, $P=.016$) 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%,

Table 1

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

Variables	Non-poverty counties	Poverty counties	Total
Breast cancer screening persons	1,736,684	1,414,995	3,151,679
Breast ultrasonography (BUS)			
Breast ultrasonography screening persons	1,725,041	1,414,046	3,139,087
0-grade	11,453	3,056	14,509
1-grade	1,184,113	1,065,950	2,250,063
2-grade	485,113	313,281	798,394
3-grade	38,826	28,998	67,824
4-grade	5,376	2,669	8,045
5-grade	160	92	252
Mammography (MAM)			
Mammography screening persons	36,277	26,300	62,577
0-grade	898	983	1,881
1-grade	7,810	5,804	13,614
2-grade	14,209	10,239	24,448
3-grade	11,885	8,247	20,132
4-grade	1,397	985	2,382
5-grade	78	42	120
Histopathological examination			
The persons who should attend the Histopathological examination	6,607	3,753	10,360
The persons of Histopathological examination	5,259	2,387	7,646
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 persons who should be given TNM staging	697	372	1,069
The persons who obtained TNM staging	621	296	917
0-staging	17	11	28
I-staging	143	75	218
IIa-staging	251	104	355
IIb-staging	108	43	151
≥III-staging	102	63	165
The persons of follow-up	806	464	1,270
The persons of treatment	800	453	1,253
Statistical indicators			
The persons of precancerous lesions and breast cancer	796	455	1,251
The persons of breast cancers	749	420	1,169
The persons of early diagnosis of breast cancer	411	190	601
Breast cancer incidence (/10^5)	43.13	29.68	37.09
The proportion of early diagnosis of breast cancer (%)	66.18	64.19	65.54

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

0-grade: incomplete assessment; further imaging evaluation and comparison with previous findings required.

1-grade: negative; positive predictive value (PPV) almost zero.

2-grade: benign; PPV almost zero.

3-grade: benign is more likely; PPV 0% to 2%.

4-grade: possibly malignant; PPV 2% to 95%.

5-grade: almost malignant; PPV 95% to 100%.

**TNM grades refer to specific pathological or clinical stages. Priority should be given to pathological staging; if no pathological stages were obtained, the clinical stages were filled in TNM stages 0, I, and IIa represent early diagnosis of breast cancer.

**Breast cancer incidence $= \frac{\text{The persons of breast cancers}}{\text{Breast cancer screening persons}} + 100,000.$

**Proportion of early diagnosis of breast cancer $= \frac{\text{The persons of early diagnosis of breast cancer}}{\text{The persons who obtained TNM staging}} \times 100\%$

$P < .001$) and with a clear edge of the solid mass (N = 140, 32.48% vs N = 53, 22.46%, $P = .02$) in the right breast were both higher in women in non-poor counties. Women with breast cancer in non-poor counties were significantly more likely to be encouraged to undergo a pathological examination compared with those in poor counties (N = 444, 59.28% vs N = 203, 48.33%, $P < .001$, respectively). Overall, BUS examination results revealed differences in cysts, margins, internal echo, and blood flow in the solid mass in the right breast between the two groups. Examination of women with breast cancer showed that patients from poor counties were more likely to have complex cysts, unclear edges, high internal echoes, an aspect ratio of the solid mass >1, and rich blood flow to the solid mass.

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	.003
2017	255	34.05	181	43.10		
2018	308	41.12	135	32.14		
Age (years)						
35–40	58	7.74	37	8.81	3.977	.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	<.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	<.001
Others	12	1.60	90	21.43		
Missing data	55	7.34	20	4.76		
Age at menarche (years)						
<13	133	17.76	61	14.52	7.988	.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		
History of fertility						
Yes	741	98.93	414	98.57	4.211	.04
No	1	0.13	4	0.95		
Missing data	7	0.93	2	0.48		
Age at fertility (years)						
18–21	261	34.85	162	21.63	3.578	.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	.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	.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	.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	.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	.489
Yes	25	3.34	11	2.62		
Missing data	6	0.80	2	0.48		

Table 3

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

	Left						Right					
	Non-poverty counties		Poverty counties			*P*	Non-poverty counties		Poverty counties			
Variables	N	%	N	%	χ^2	N	%	N	%		χ^2	*P*
Cyst												
None	615	82.11	332	79.05	1.52	.468	594	79.31	311	74.05	8.23	.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	.346	318	42.46	184	43.81	0.253	.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	.108	20	4.64	12	5.08	1.347	.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	.039	164	38.05	76	32.20	0.005	.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	.261	108	25.06	55	23.31	0.807	.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	.028	140	32.48	53	22.46	5.451	.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	.738	14	3.25	15	6.36	14.38	.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		
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	.053	187	43.39	83	35.17	5.73	.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	.14	177	41.07	95	40.25	2.361	.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	.519	156	36.19	51	21.61	16.79	<.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	.224	15	2.00	9	2.14	8.22	.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		

Table 4

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

	Left						Right					
	Non-poverty counties		Poverty counties			*P*	Non-poverty counties		Poverty counties			
Variables	N	%	N	%	χ^2	N	%	N	%		χ^2	*P*
Classification												
0	4	1.11	3	1.41	2.877	.719	8	2.22	3	1.41	3.257	.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	.587	140	38.89	82	38.50	0.037	.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	.951	74	20.56	40	18.78	0.329	.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	.006	71	19.72	28	13.15	4.009	.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	.222	7	1.94	5	2.35	3.562	.469
Up inside	7	1.94	0	0.00			7	1.94	1	0.47		
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		

3.4. Comparison of MAM results in relation to county poverty level

Women with breast cancers in poor counties were significantly more likely to have a structural disorder in the solid mass in both the left (N=54, 25.35% vs N=85, 23.61%, $P=.006$) and right breasts (N=48, 22.54% vs N=68, 18.89%, $P=.045$), and to be followed-up with a pathological examination (N=201, 47.86% vs N=323, 43.12%, $P=.022$) (Table 4). Women in poor counties thus had larger breast tumors based on MAM results for both breasts.

The patients' pathological characteristics are displayed in Table 5. Regarding clinical and pathological staging, breast cancers were staged to a lesser extent in poor compared with non-poor counties (N=203, 49.27% vs N=484, 65.58%, $P<.001$ and N=187, 45.39% vs N=439, 59.49%, $P<.001$, respectively). Breast cancers in women in non-poor counties were significantly more likely to be considered as c-TNM clinical staging grade 2 (N=282, 59.75%, N=82, 43.62%, $P=.008$) and p-TNM clinical staging grade 2 (N=245, 57.92%, N=72, 41.62%, $P=.009$). However, breast cancer patients in poor counties were significantly less likely to be treated following a pathological diagnosis (N=394, 93.81%, N=713, 95.19%, $P=.026$). Breast cancer cases in poor counties were less likely to undergo clinical and pathological staging in both breasts compared with women in non-poor counties.

3.5. Multivariate logistic regression analysis of risk factors among breast cancer patients in poor counties

Data for 1015 women from poor counties with breast cancer were analyzed by multivariate logistic regression analysis, after deleting cases with missing values of analysis variables. The following risk factors were identified as related to breast cancer in poor counties: year (2017 compared with 2016), education, ethnicity, and reproductive history (odds ratio >1, $P<.05$). All results of the analysis are listed in Table 6.

4. Discussion

To the best of our knowledge, this is the first study analyzing data from the population breast cancer screening program in China. In this study, we explored differences in the effects of implementing the breast cancer screening program and in clinical examination results between breast cancer patients in poor and non-poor counties in rural areas of Hunan province from 2016 to 2018. The results showed that indexes of the breast screening program including the proportion of breast cancers detected early, breast cancer prevalence, the proportion of breast cancer patients who underwent pathological examination, and the MAM examination rate were all lower in poor compared with non-poor counties. The prevalence of breast cancer was lower in poor

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*	Variables	Non-poverty counties		Poverty counties		χ^2	*P*
	N	%	N	%			N	%	N	%		
	Pathological examination							Classification					
Yes	738	98.53	412	98.10	0.038	.846	Dysplasia	1	0.14	0	0.00		.569*
No	3	0.40	2	0.48			Invasive lobular carcinoma	70	9.49	38	9.22		
Missing data	8	1.07	6	1.43			Invasive ductal carcinoma	570	77.24	309	75.00		
Total	749	100.00	420	100.00			Invasive lobular carcinoma and Invasive ductal carcinoma	1	0.14	1	0.24		
Treatment							fibrous adenoma	6	0.81	0	0.00		
Yes	713	95.19	394	93.81	4.936	.026	Lobular carcinoma in situ	2	0.27	0	0.00		
No	4	0.53	9	2.14			Other types	25	3.39	12	2.91		
Missing data	32	4.27	17	4.05			Missing data	63	8.54	52	12.62		
Total	749	100.00	420	100.00			Total	738	100.00	412	100.00		
Clinical staging							Pathological staging						
Obtainment	484	65.58	203	49.27	27.887	<.001	Obtainment	439	59.49	187	45.39	15.054	<.001
Not-obtainment	191	25.88	163	39.56			Not-obtainment	216	29.27	156	37.86		
Missing data	63	8.54	46	11.17			Missing data	83	11.25	69	16.75		
Total	738	100.00	412	100.00			Total	738	100.00	412	100.00		
c-TNM clinical staging†							p-TNM clinical staging†						
Yes	472	97.52	188	92.61	0.229	.633	Yes	423	96.36	173	92.51	0.209	.648
No	8	1.65	5	2.46			No	10	2.28	6	3.21		
Missing data	4	0.83	10	4.93			Missing data	6	1.37	8	4.28		
Total	484	100.00	203	100.00			Total	439	100.00	187	100.00		
c-TNM clinical staging grate†							p-TNM clinical staging grate†						
0	4	0.85	1	0.53		.008*	0	4	0.95	2	1.16		.009*
1	103	21.82	48	25.53			1	88	20.80	51	29.48		
2	282	59.75	82	43.62			2	245	57.92	72	41.62		
3	64	13.56	41	21.81			3	66	15.60	37	21.39		
4	7	1.48	3	1.60			4	8	1.89	3	1.73		
Missing data	12	2.54	13	6.91			Missing data	12	2.84	8	4.62		
Total	472	100.00	188	100.00			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 staging and 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 manual made by American Joint Committee on Cancer (AJCC).

areas, in accordance with the results of other studies.[16–18] However, the prevalence of breast cancer in rural areas of Hunan province in our study was $37.09/10^5$, which was higher than the $25.28/10^5$ reported in rural areas of China in 2010 based on 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 to 2010.[19] Furthermore, the prevalence was lower than the $73.4/10^5$ reported in developed countries but higher than the $31.3/10^5$ in developing countries, according to global cancer statistics from 2012.[20] Breast cancer patients in poor rural areas were relatively undereducated and underwent menarche at an older age compared with patients in non-poor areas. Worldwide, the prevalence of breast cancer increases in parallel with socioeconomic development, and breast cancer risk has changed in parallel with socioeconomic development and urbanization in

Table 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, and breastfeeding history.

China over the past three decades.[18] The allocation of and accessibility to health resources is reduced in poor counties compared with non-poor counties, resulting in lower pathological examination and MAM rates. Regional differences in breast cancer prevalence and allocation of and accessibility to health resources should thus be taken into account when planning breast screening programs.[21]

The present study identified 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. Furthermore, multivariate 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 diagnosed with breast cancer.

Racial disparity persists in breast screening, such as between Hispanic and non-Hispanic white women.[21] In this present study, women of non-Han ethnicity had a lower education level and socioeconomic status, and reduced access to health care. Age at menarche was identified as a breast cancer risk factor[22,23] and early menarche has been associated with an increased risk of breast cancer.[24] Western style fast food and high-sugar drinks have become increasingly 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.[25] Age at menarche (>13 years compared with ≤13 years) was not found to be a risk factor after adjusting for all the variables with 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 poorer general health than individuals living in relatively developed areas.[26,27] This could also help to explain the current differences in breast cancer screening results between women in poor and non-poor counties.

Doctors more readily advised women with breast cancer in poor counties to receive pathological examination following BUS and MAM examinations. However, the proportion of women receiving treatment for breast cancer in poor counties was lower than that for women in non-poor counties, indicating that women with breast cancer in poor counties had a higher rate of malignancy and reduced access to medical services, despite the lower prevalence 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 >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 prevalence of breast cancer than white women.[28] Nguyen-Pham et al found that breast cancer patients from rural areas had 1.19-fold higher odds of being diagnosed with late-stage breast cancer compared with patients from urban areas.[29] Anderson et al concluded that a lack of breast cancer screening and living in poorer rural areas were associated with a 3.31-fold increase in the rate of diagnosis of later-stage breast cancer in Appalachia, compared with women living in less deprived regions.[30,31] Socioeconomic status has been identified as a key determinant of cancer stage at diagnosis in western countries,[32] and a systematic study of the relationship between socioeconomic status and breast cancer stage at diagnosis in China 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.[11] The current results suggested that women with breast cancer in poor counties are in need of more diagnostic and clinical, rather than screening services. This finding emphasizes the fact that just providing free screening services cannot make up for a lack of preventive care for low-income and uninsured women.[33]

Environmental factors play an important role in the development of cancer and suggest that region-tailored cancer prevention strategies are warranted.[34] To improve breast cancer outcomes in rural areas of China, we suggest that free screening services should be supported by more diagnostic and clinical services as a long-term policy to benefit women in rural areas, and that these services should 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 register. Importantly, we could not analyze and compare the age distributions between poor and non-poor counties to determine if the apparently lower prevalence of breast cancer in poor counties was due to the age distribution because of data unavailability. Second, there was recall bias regarding the basic information obtained for the breast cancer cases. Third, although the whole province carried out a unified training for all doctors involved in administering BUS, MAM, and pathological examinations, there were differences in the qualities of the examinations and information filling, which also led to information missing.

5. Conclusions

Analysis of population-based breast cancer screening programs in rural areas revealed differences in the evaluation indicators and clinicopathological characteristics of the breast cancer cases in relation to county-level poverty status. Although the prevalence of breast cancer was lower in poor than in non-poor counties, women in poor areas were more likely to be diagnosed at later stage than those in non-poor areas, and additional diagnostic and clinical services should be provided in poor areas to address these concerns.

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