

Influence of occupation and education level on breast cancer stage at diagnosis, and treatment options in China

A nationwide, multicenter 10-year epidemiological study

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Abstract

The objective of this study was to evaluate the impact of occupation and education level of Chinese female breast cancer patients on their cancer staging at diagnosis, clinical and pathological features, rate of implementation, and selection of treatment.

The medical charts of 4211 confirmed female breast cancer cases diagnosed between 1999 and 2008, from 7 breast cancer centers spread across the whole of China, were reviewed. Data including information on the patient's sociodemographic status, clinical and pathological characteristics, implementation of clinical examination and treatment modalities were analyzed. In parallel, the associations between different occupations and level of educational attainment were analyzed in relation to tumor stage through TNM staging, clinical and pathological characteristics, implementation of clinical examination, and treatment patterns. Multivariate logistic regression was used to identify whether the occupation and education level of patients are independent factors of TNM staging at diagnosis.

There were significant differences among different occupation groups and the education level of patients in regards to pathological characteristics and treatment choice. Both the occupation and education level of patients were independent factors of TNM staging at diagnosis. For patients within the lower-income occupation or lower educational attainment group, the tumor stage was later, the rates of implementation of relevant investigations were lower, as were the rates of radiotherapy, chemotherapy, and endocrine therapy.

This study suggests that strategies should work toward developing more accurate and effective breast cancer prevention and treatment strategies aimed specifically at patients with lower educational attainment levels and at specific occupation groups.

Abbreviations: AJCC = American Joint Committee on Cancer, BMI = body mass index, CI = confidence interval, CRF = case report form, ER = estrogen receptor, Her2 = human epidermal growth factor receptor 2, MRI = magnetic resonance imaging, OR = odds ratio, PR = progesterone receptor, SE = standard error.

Keywords: breast cancer, clinical and pathological characteristics, education level, occupation, TNM staging, treatment patterns

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1. Introduction

Breast cancer is the most common cancer and the leading cause of cancer death among females worldwide, accounting for 25% of all cancer cases and 15% of all cancer-related deaths among females.^[1] In 2012, there were nearly 190,000 new diagnoses of breast cancer in China alone and >47,000 deaths representing a substantial economic and societal burden.^[2,3] Early detection and early treatment of breast cancer have been shown to among the most effective methods to address the impact of this devastating disease.^[3]

Substantial evidence indicates that the socioeconomic status (SES) of breast cancer patients has a significant impact on prognosis through its associated influence on the cancer stage at diagnosis. Previous findings suggest people with lower incomes have a later cancer stage at point of diagnosis and a worse overall prognosis.^[4–6] Socioeconomic status is also significantly associated with education level and occupation, both of which can greatly influence patients' perception of the tumor, thereby affecting the level of early detection, diagnosis, and treatment.^[7,8] Our previous single-center study confirmed that occupation and education level of patients had a significant impact on TNM staging at diagnosis, clinical and pathological characteristics, rate of implementation of clinical examination, and the selection of treatment modalities.^[9] We hypothesized that similar findings also existed across the whole of China.

This study looked to further confirm these associations in an epidemiological retrospective study of 10 years (1999–2008) with the participation of 7 regional representative hospitals in China, which related data can represent the status quo of diagnosis and treatment of breast cancer in recent China.^[5,10–12] These data will enable us to adapt diagnosis and treatment modalities for patients with different social backgrounds to improve their overall prognosis. What's more, as China is a typical developing country, the results can also provide a reference for other developing countries to formulate corresponding policies of diagnosis and treatment.

2. Methods

2.1. Ethics statement

This study was approved by the institutional review board, Cancer Foundation of China. Patient consent was not required for this study because there were no anticipated risks for the participants of the study. All patient identifiers were removed per the board-approved procedures. Deidentified data were maintained in a secure database, to which only research team members had access.^[13]

2.2. Selection of hospitals and patients

Hospital selection and case sampling methods have been previously described in detail.^[13] In brief, China was stratified into 7 geographical areas (north, northeast, northwest, east, central, south, and southwest). We selected 1 tertiary public cancer hospital in each region with the following characteristics. First of all, participant hospitals had to be the leading regional public cancer hospitals and referral centers that provide pathology diagnosis, surgery, medical oncology, radiotherapy, and routine follow-up care for breast cancer patients. Second, patients of the selected hospitals must include the entire study region. Another criterion was that the hospitals had to be located in a major city.^[13]

The participant hospitals provided us with the medical records of female breast cancer patients diagnosed during 1999 to 2008. One month was randomly selected within each year and all inpatient cases for that month were reviewed. January and February were excluded because Chinese traditional spring festival always fall in these 2 months and there are much fewer inpatients during this period.^[13] All cases within the selected month were reviewed and patient's information was collected based on the designed case report form (CRF). If qualifying cases were <50 in a selected month, additional cases from the following months were reviewed until the total number reaches 50. Whereas, if the number of patients exceeded 50 in the selected month, all cases should be reviewed.^[13] Patients' information was collected based on the standard CRF designed by the Cancer Institute of the Chinese Academy of Medical Sciences. As such, a total of 4211 female breast cancer patients were included in the study.^[5,10–12]

2.3. Pathology diagnostic criteria

The histological subtype categorization was based on the 1981 and 2003 WHO histological classification criteria.^[11,14] Staging of breast cancer was categorized according to the American Joint Committee on Cancer (AJCC) TNM System of year 1997^[15] and 2002.^[16] The specific details were described in our previous

study,^[13] and we grouped the staging of breast cancer into 2 categories: "early" (stages 0, I, and II) or "advanced" (stages III and IV).^[13]

2.4. Categorization of occupation and education level

According to our previous study, the occupations of patients were classified into 5 groups: manual worker, housewife, private sector worker, professional, and unspecified.^[9] By convention, we grouped the education levels of patients into 6 categories: none (never having received any formal education), those having received formal education of primary, middle, high, or university, and above, and unspecified.^[13,17]

2.5. Statistical analysis

Descriptive statistics were used to summarize the clinical and pathologic characteristics, implementation of clinical examination, and treatment options of the study population. Measurement data were expressed as mean \pm standard deviation (SD), and the differences in the distribution of variables among groups were analyzed using χ^2 tests. Additionally, multivariate logistic regression analysis was performed to further explore the associations between individual demographic characteristics and breast cancer stage at diagnosis (advanced stage vs. early stage). SPSS statistical software version 17.0 (SPSS Inc, Chicago, IL) was used to analyze the data. A 2-tailed $P < 0.05$ was considered statistically significant.

3. Results

3.1. General information of patients

A total of 4211 cases were included in this multicenter study, in which the distribution of patient's occupation within the 5 categories was composed of 4% housewives (173/4211), 45% manual workers (1893/4211), 24.4% professionals (1028/4211), 12.6% private sector workers (529/4211), and 14% unspecified (588/4211). The proportion of patients' levels of education were 4.4% uneducated (186/4211), 11% primary (462/4211), 14.4% middle school (606/4211), 10.5% high school (441/4211), 9.4% university and above (396/4211), and 50.3% unknown (2120/4211). Further details were shown in Table 1 including the average age at diagnosis, mean body mass index (BMI), clinical and pathologic characteristics, and treatment patterns of all patients.

3.2. Occupation

3.2.1. Comparison of clinical and pathologic characteristics among different occupations.

There were significant differences between different occupations in several clinical and pathological characteristics in this study. For tumor size, the proportion of professionals with tumors <2cm was 36.3%, significantly higher than in other occupations ($P < .001$); for comparison, the proportion of manual workers was 27.6%. Significant differences were also seen with regards to TNM staging. Manual workers had fewer reports of early breast cancer (61.7%) and the highest proportion of advanced breast cancer (26.3%) ($P < .001$). Hormone receptor (HR) expression status (estrogen receptor [ER] and/or progesterone receptor [PR]) was significantly different ($P = .001$), with manual workers having the lowest HR-positive rate (61.2%) and the highest negative rate (31.5%). No significant differences were observed in expression

Table 1**Overview of characteristics of the 4211 breast cancer patients included in the study.**

Characteristics		No. of case (%)
Mean age at diagnosis, y [*]	48.68 ± 10.47	4211
Body mass index, kg/m ^{2†}	23.35 ± 2.89	4211
Sex	Female	4211
Occupation	House wife	173 (4)
	Manual worker	1893 (45)
	Professional	1028 (24.4)
	Private sector worker	529 (12.6)
	Unspecified	588 (14)
Education	None	186 (4.4)
	Primary school	462 (11)
	Middle school	606 (14.4)
	High school	441 (10.5)
	University and above	396 (9.4)
	Unspecified	2120 (50.3)
Marital status	Single	51 (1.2)
	Married	4090 (97.1)
	Widowed/divorced	52 (1.2)
	Unknown	18 (0.5)
Preoperative mammography [‡]	Not done	807 (19.2)
	Done	2837 (67.4)
	Unspecified	567 (13.4)
Primary tumor location	Left	2189 (52)
	Right	1995 (47.4)
	Unspecified	27 (0.6)
Tumor size	≤2 cm	1229 (29.2)
	2–5 cm	1994 (47.4)
	>5 cm	356 (8.4)
	Unspecified	632 (15)
No. of tumor nodules	1	3182 (75.6)
	≥2	110 (2.6)
	Unspecified	919 (21.8)
Local invasion	None	3480 (82.7)
	Skin or chest wall invasion	183 (4.3)
	Unspecified	548 (13)
Surgery	Not Done	107 (2.5)
	Radical mastectomy	470 (11.2)
	Modified radical mastectomy	3270 (77.6)
	Breast conservative surgery	231 (5.5)
	Simple mastectomy	46 (1.1)
	Unspecified	87 (2.1)
Pathological diagnosis	Carcinoma in situ	143 (3.4)
	Invasive ductal carcinoma	3471 (82.4)
	Other type invasive carcinoma	385 (9.1)
	Others	15 (0.4)
	Unavailable	197 (4.7)
pTNM stage	0	39 (0.9)
	I	663 (15.7)
	II	1891 (44.9)
	III	788 (18.7)
	IV	113 (2.7)
	Unspecified	717 (17.1)
	ER/PR status	ER+ and PR+
	ER+ and PR–	337 (9)
	ER– and PR+	367 (9.8)
	ER– and PR–	1139 (30.5)
	Unspecified	206 (5.5)
Her2 status	Her2+	736 (21.3)
	Her2–	2113 (61.3)
	Unspecified	600 (17.4)
Radiotherapy	Not done	2723 (64.7)
	Done	952 (22.6)
	Unspecified	536 (12.7)
Chemotherapy	Not done	626 (14.9)

Table 1. (Continued)

Characteristics	No. of case (%)	
Endocrine Therapy	Done	3428 (81.4)
	Unspecified	156 (3.7)
	Not done	2092 (49.7)
	Done	1599 (38)
	Unspecified	520 (12.3)

ER=estrogen receptor, Her2=human epidermal growth factor receptor 2, PR=progesterone receptor.

^{*}Data were presented as mean ± standard deviation (SD) (mean ± SD, 1999–2008).

[†]body mass index = weight/height² (mean ± SD, 1999–2008), missing body mass index values were replaced with the mean from available data, 23.35 kg/m².

[‡]Preoperative mammography—ultrasonography, mammography, or magnetic resonance imaging examination of breast before surgery.

of human epidermal growth factor receptor 2 (Her2) status among different occupations ($P=.123$) (Table 2).

3.2.2. Comparison of implementation of clinical examination among different occupations.

The data in Table 2 showed there were significant differences between different occupations in the preoperative imaging implementation rate (underwent breast ultrasound, mammography or magnetic resonance imaging [MRI] before surgery), and the implementation rate of postoperative detection of ER/PR and Her2 ($P<.001$), which both showed similar trends that the implementation rate of manual workers was lower than that of professionals (65.4% vs. 65.7%; 79.3% vs. 87.8%; 70.7% vs. 79.4%).

3.2.3. Comparison of treatment patterns among different occupations.

The above results indicated that breast cancer patients with different occupations had significant differences in their clinical and pathological characteristics and implementation rate of related evaluation, which may further affect patients and doctor's choice of treatment patterns. The results in Table 2 showed first that the choice of surgical approach of patients in different occupation groups was significantly different ($P<.001$), in which implementation of radical surgery (radical mastectomy + modified radical mastectomy) in the professionals group was lowest (86.3%), whereas implementation of breast-conserving surgery was highest (10.1%). In contrast, corresponding implementation rates in manual workers were 90.4% and 3.6%, respectively. Second, there were significant differences ($P<.001$) between patients with different occupations in considering whether to receive radiotherapy; the implementation rates were 28% for professionals, 23% for manual workers, 20.8% for private sector staff, and 9.8% for housewives. Third, patients within different occupation groups also showed significant differences ($P=.026$) in whether they received chemotherapy; the implementation rates were 85% for housewives, 83.3% for private sector staff, 82.2% for manual workers, and 80.2% for professionals. Fourth, finally there were significant differences in whether patients with hormone-receptor positive (HR+) breast cancer received endocrine therapy among the different occupation groups ($P<.001$) with implementation rates of 73.2% for housewives, 64.8% for professionals, 61.2% for private sector staff, and 55% for manual workers.

3.3. Education level

3.3.1. Comparison of clinical and pathologic characteristics of patients with differing education levels. The data in Table 3 showed that different education backgrounds had a significant impact on TNM staging distribution ($P<.001$); the group with

Table 2
Comparison of different characteristics amongst occupations.

Characteristics		House wife (173)	Manual worker (1893)	Professional (1028)	Private sector worker (529)	Unspecified (588)	P
Preoperative mammography*	Not done	33 (19.1)	388 (20.6)	230 (22.5)	78 (14.7)	78 (13.3)	<.001
	Done	130 (75.1)	1239 (65.4)	675 (65.7)	352 (66.5)	441 (75.0)	
	Unspecified	10 (5.8)	266 (14)	123 (11.8)	99 (18.8)	69 (11.7)	
ER and PR test	Not done	11 (6.4)	278 (14.7)	86 (8.4)	36 (6.8)	60 (10.2)	<.001
	Done	153 (88.4)	1501 (79.3)	903 (87.8)	461 (87.1)	511 (86.9)	
	Unspecified	9 (5.2)	114 (6.0)	39 (3.8)	32 (6.1)	17 (2.9)	
Her2 test	Not done	23 (13.3)	438 (23)	171 (16.6)	53 (10.0)	77 (13.1)	<.001
	Done	141 (81.5)	1337 (70.7)	816 (79.4)	444 (84.0)	494 (84.0)	
	Unspecified	9 (5.2)	118 (6.3)	41 (4.0)	32 (6.0)	17 (2.9)	
ER/PR status	ER+ and PR+	86 (53.1)	689 (42.7)	438 (46.6)	228 (46.2)	250 (47.3)	.001
	ER+ and PR−	14 (8.6)	152 (9.4)	89 (9.4)	40 (8.1)	42 (8.0)	
	ER− and PR+	12 (7.4)	147 (9.1)	89 (9.4)	59 (12.0)	60 (11.4)	
	ER− and PR−	41 (25.3)	509 (31.5)	291 (30.9)	136 (27.6)	162 (30.7)	
	Unspecified	9 (5.6)	118 (7.3)	35 (3.7)	30 (6.1)	14 (2.6)	
Her2 status	+	29 (19.3)	313 (21.5)	175 (20.4)	113 (23.7)	106 (20.7)	.123
	−	96 (64.0)	856 (58.8)	544 (63.5)	289 (60.7)	328 (64.2)	
	Unspecified	25 (16.7)	286 (19.7)	138 (16.1)	74 (15.6)	77 (15.1)	
Surgery	Not done	1 (0.6)	50 (2.6)	11 (1.1)	20 (3.8)	25 (4.2)	<.001
	Radical mastectomy	23 (13.3)	241 (12.7)	103 (10.0)	60 (11.4)	43 (7.3)	
	Modified radical mastectomy	136 (78.6)	1471 (77.7)	784 (76.3)	403 (76.2)	476 (81.0)	
	Breast conservative surgery	5 (2.9)	68 (3.6)	104 (10.1)	25 (4.7)	29 (4.9)	
	Simple mastectomy	3 (1.7)	24 (1.3)	10 (0.9)	5 (0.9)	4 (0.7)	
	Unspecified	5 (2.9)	39 (2.1)	16 (1.6)	16 (3.0)	11 (1.9)	
Radiotherapy	Undone	146 (84.4)	1196 (63.2)	652 (63.4)	358 (67.7)	371 (63.1)	<.001
	Done	17 (9.8)	435 (23.0)	287 (28.0)	110 (20.8)	103 (17.5)	
	Unspecified	10 (5.8)	262 (13.8)	89 (8.6)	61 (11.5)	114 (19.4)	
Chemotherapy	Undone	19 (11.0)	274 (14.5)	173 (16.8)	62 (11.7)	98 (16.7)	.026
	Done	147 (85)	1556 (82.2)	824 (80.2)	440 (83.3)	461 (78.4)	
	Unspecified	7 (4.0)	63 (3.3)	31 (3.0)	26 (5.0)	29 (4.9)	
Endocrine therapy†	Undone	22 (19.6)	272 (27.5)	140 (22.7)	90 (27.5)	102 (29)	<.001
	Done	82 (73.2)	543 (55)	399 (64.8)	200 (61.2)	160 (45.5)	
	Unspecified	8 (7.2)	173 (17.5)	77 (12.5)	37 (11.3)	90 (25.5)	
Tumor size	≤2 cm	49 (28.3)	523 (27.6)	373 (36.3)	152 (28.8)	132 (22.4)	<.001
	2–5 cm	100 (57.8)	926 (48.9)	439 (42.7)	207 (39.1)	322 (54.8)	
	>5 cm	7 (4.1)	178 (9.4)	63 (6.1)	54 (10.2)	54 (9.2)	
	Unspecified	17 (9.8)	266 (14.1)	153 (14.9)	116 (21.9)	80 (13.6)	
pTNM stage‡	Early	127 (74.3)	1112 (61.7)	672 (66.5)	313 (60.5)	369 (63.2)	<.001
	Late	26 (15.2)	474 (26.3)	189 (18.7)	107 (20.7)	105 (18.0)	
	Unspecified	18 (10.5)	216 (12.0)	149 (14.8)	97 (18.8)	110 (18.8)	

ER=estrogen receptor, Her2=human epidermal growth factor receptor 2, PR=progesterone receptor.

* Preoperative mammography—ultrasonography, mammography, or magnetic resonance imaging examination of breast before surgery.

† The implementation rates of endocrine therapy were calculated for patients with hormone receptor-positive (HR+) breast cancer.

‡ Early including stages 0, I, and II, late including stages III and IV.

the highest rate of early breast cancer was those educated to university and above (73.3%) whilst the lowest was within the uneducated group (65.1%). Conversely the highest rate of advanced breast cancer at diagnosis was found within the uneducated group (31.5%) and the lowest was university and above (17.7%). There were no significant differences in other clinical and pathologic characteristics such as tumor size for each group. Different levels of education did however have a significant impact on HR (ER and/or PR) expression status ($P < .001$), in which the highest HR-positive rate was within the uneducated group (66.4%). The highest HR-negative rate was found in the university and above education group (35.2%) and the lowest was within the uneducated group (24.7%). The status of Her2 expression between different groups also showed significant differences ($P = .007$); the uneducated group had the lowest Her2 positive rate (11.5%) and the highest negative rate (66.9%).

3.3.2. Comparison of implementation of clinical examination across different education levels. The data in Table 3 showed there were significant differences among different education backgrounds in the implementation rate of preoperative imaging examination and postoperative detection of ER/PR and Her2 ($P < .001$). The implementation rate of preoperative imaging examination was highest in the group of education level of university and above (66.7%) and the lowest was within the high school group (55.8%). And the overall trend of implementation of detecting ER/PR and Her2 was that the higher the education level was, the higher the implementation rate of detection (Table 3).

3.3.3. Comparison of treatment patterns across different education levels. Different education levels may result in different awareness of breast cancer which can affect the patient's choice in treatment. The data in Table 3 indicated that the

Table 3
Comparison of different characteristics amongst education levels.

Characteristics	None (186)	Primary school (462)	Middle school (606)	High school (441)	University and above (396)	Unspecified (2120)	P
Preoperative mammography*							<.001
Not done	42 (22.6)	89 (19.3)	157 (25.9)	144 (32.7)	97 (24.5)	278 (13.1)	
Done	118 (63.4)	302 (65.4)	359 (59.2)	246 (55.8)	264 (66.7)	1548 (73)	
Unspecified	26 (14)	71 (15.3)	90 (14.9)	51 (11.5)	35 (8.8)	294 (13.9)	
ER and PR test							<.001
Not done	28 (15.1)	53 (11.5)	83 (13.7)	40 (9.1)	24 (6.1)	243 (11.4)	
Done	145 (77.9)	370 (80.0)	484 (80.0)	390 (88.4)	361 (91.2)	1779 (84)	
Unspecified	13 (7.0)	39 (8.5)	39 (6.3)	11 (2.5)	11 (2.7)	98 (4.6)	
Her2 test							<.001
Not done	38 (20.4)	70 (15.1)	115 (19.0)	59 (13.4)	41 (10.3)	439 (20.7)	
Done	133 (71.5)	351 (76.0)	450 (74.3)	367 (83.2)	343 (86.6)	1588 (75)	
Unspecified	15 (8.1)	41 (8.9)	41 (6.7)	15 (3.4)	12 (3.1)	93 (4.3)	
ER/PR status							<.001
ER+ and PR+	74 (46.8)	170 (41.6)	216 (41.3)	187 (46.6)	159 (42.8)	885 (47.1)	
ER+ and PR−	16 (10.1)	39 (9.5)	34 (6.5)	33 (8.2)	35 (9.4)	180 (9.6)	
ER− and PR+	15 (9.5)	28 (6.8)	54 (10.3)	41 (10.2)	37 (9.9)	192 (10.2)	
ER− and PR−	39 (24.7)	130 (31.8)	174 (33.3)	127 (31.7)	131 (35.2)	538 (28.7)	
Unspecified	14 (8.9)	42 (10.3)	45 (8.6)	13 (3.3)	10 (2.7)	82 (4.4)	
Her2 status							.007
+	17 (11.5)	82 (20.9)	102 (20.8)	70 (18.3)	70 (19.7)	395 (23.5)	
−	99 (66.9)	236 (60.2)	300 (61.1)	254 (66.5)	236 (66.5)	988 (58.8)	
Unspecified	32 (21.6)	74 (18.9)	89 (18.1)	58 (15.2)	49 (13.8)	298 (17.7)	
Surgery							<.001
Not done	5 (2.7)	14 (3.0)	16 (2.6)	7 (1.6)	4 (1.0)	61 (2.9)	
Radical mastectomy	50 (26.9)	83 (18.0)	100 (16.5)	56 (12.7)	36 (9.1)	145 (6.8)	
Modified radical mastectomy	121 (65.1)	340 (73.6)	459 (75.7)	348 (78.9)	312 (78.8)	1690 (79.8)	
Breast conservative surgery	3 (1.6)	9 (1.9)	10 (1.7)	13 (2.9)	34 (8.6)	162 (7.6)	
Simple mastectomy	3 (1.6)	3 (0.6)	8 (1.3)	8 (1.8)	2 (0.5)	22 (1.0)	
Unspecified	4 (2.1)	13 (2.9)	13 (2.2)	9 (2.1)	8 (2.0)	40 (1.9)	
Radiotherapy							<.001
Undone	111 (59.7)	304 (65.8)	414 (68.3)	308 (69.8)	272 (68.7)	1314 (62)	
Done	28 (15.0)	89 (19.3)	129 (21.3)	110 (25.0)	88 (22.2)	508 (24)	
Unspecified	47 (25.3)	69 (14.9)	63 (10.4)	23 (5.2)	36 (9.1)	298 (14)	
Chemotherapy							<.001
Undone	28 (15.1)	58 (12.6)	83 (13.7)	44 (10.0)	43 (10.9)	370 (17.6)	
Done	147 (79.0)	391 (84.6)	509 (84.1)	389 (88.2)	351 (88.6)	1641 (77)	
Unspecified	11 (5.9)	13 (2.8)	13 (2.2)	8 (1.8)	2 (0.5)	109 (5.4)	
Endocrine therapy†							<.001
Undone	26 (24.8)	66 (27.8)	68 (22.4)	67 (25.7)	56 (24.2)	343 (27.3)	
Done	55 (52.4)	152 (64.1)	211 (69.4)	185 (70.9)	161 (69.7)	620 (49.3)	
Unspecified	24 (22.8)	19 (8.1)	25 (8.2)	9 (3.4)	14 (6.1)	294 (23.4)	
Tumor size							.145
≤2 cm	63 (33.9)	156 (33.8)	181 (29.9)	130 (29.5)	117 (29.5)	582 (27.4)	
2–5 cm	82 (44.1)	210 (45.5)	263 (43.4)	201 (45.6)	186 (47.0)	1052 (50)	
>5 cm	12 (6.5)	38 (8.2)	52 (8.6)	44 (10.0)	33 (8.3)	177 (8.2)	
Unspecified	29 (15.5)	58 (12.5)	110 (18.1)	66 (14.9)	60 (15.2)	309 (14.4)	
pTNM stage‡							<.001
Early	114 (65.1)	276 (65.2)	376 (66.3)	283 (66.0)	285 (73.3)	1259 (60)	
Late	55 (31.5)	115 (27.2)	141 (24.9)	106 (24.7)	69 (17.7)	415 (19.8)	
Unspecified	6 (3.4)	32 (7.6)	50 (8.8)	40 (9.3)	35 (9.0)	427 (20.2)	

ER=estrogen receptor, Her2=human epidermal growth factor receptor 2, PR=progesterone receptor.

* Preoperative mammography—ultrasonography, mammography, or magnetic resonance imaging examination of breast before surgery.

† The implementation rates of endocrine therapy were calculated for patients with hormone receptor-positive (HR+) breast cancer.

‡ Early including stages 0, I, and II, late including stages III and IV.

implementation rate of radical surgery (radical mastectomy + modified radical mastectomy) was lower in groups with higher educational status. Nevertheless, the higher the education level was, the higher the rate of implementation of breast-conserving surgery. Patients with different education backgrounds also had significant differences in implementation of radiotherapy, chemotherapy, and endocrine therapy ($P < .001$) (Table 3).

3.3.4. Multivariate analysis. Univariate analysis described above showed that occupation and education levels of patients can significantly affect TNM staging of breast cancer at diagnosis. To determine whether the occupation and education status of patients were independent factors affecting tumor stage, we next conducted multivariate analysis. In response to the results of previous studies, we included a number of other factors,

Table 4**Multivariable logistic regression for association between individual demographic characteristics and breast cancer stage (stage 0, I, and II, stages III and IV) at diagnosis.**

Variables	Coefficient	SE	OR	95% CI, lower	95% CI, upper	P
Age at diagnosis, y	-0.004	0.005	0.996	0.986	1.006	.460
BMI	0.0463	0.0158	1.047	1.015	1.080	.003
Married versus single	-0.608	0.385	0.544	0.256	1.157	.114
Widowed/divorced vs. single	-1.220	0.616	0.295	0.088	0.988	.048
House wife vs. manual worker	-0.948	0.269	0.388	0.229	0.657	.000
Professional vs. manual worker	-0.380	0.118	0.684	0.542	0.862	.001
Private sector worker vs. manual worker	-0.138	0.138	0.871	0.664	1.142	.318
Highest GDP vs. others	-0.605	0.143	0.546	0.413	0.723	.000

BMI = body mass index, CI = confidence interval, OR = odds ratio, SE = standard error.

which may be related to TNM staging such as age at diagnosis, BMI, marital status (divided into 3 types: single, married, and widowed or divorced) at diagnosis, and regional Gross Domestic Product (GDP).^[5,10] As GDP of Beijing is much higher than across other areas within the study, we classified this area as a separate category.^[5]

Owing to incomplete data regarding education status in Beijing, we did not include education level in the first multivariate analysis. The results of the 2343 cases included in the multivariate analysis (1787 early cases and 556 advanced cases) suggested that BMI, marital status, occupation, and GDP were all independent factors affecting the TNM staging at diagnosis, within which BMI was an independent risk factor. In the case of controlling other risk factors, each unit increase in BMI was associated with 4.7% increased risk of an advanced breast cancer. Compared to manual workers, the other occupations were protective factors. Compared with the unmarried group, divorced or widowed were protective factors. Finally, compared with the low GDP regions, high GDP was a protective factor (Table 4).

A smaller subset for which we were able to gain education status information was then analyzed through multivariate analysis. We classified the education level for this analysis into 3 types, including uneducated and primary education, middle and high school education, and universities and above. We included a total of 1431 cases this time (1074 early cases and 357 advanced cases). The results suggested that BMI, education, and occupation were independent factors affecting tumor staging, in which BMI was once again an independent risk factor. Compared with primary education, University and above education was an independent protective factor. Compared to manual workers, housewives were independent protective factors, whereas the

professionals were not (Table 5). Owing to some debate over the classification of clinical stage of breast cancer, wherein certain researchers believe early stage should be defined as stage 0 and I only, with the remaining stages being classified as advanced stage,^[5] we also adopted this variation of classification to analyze the data a second time. The results showed that occupation and education were still independent factors that influence tumor stage, which is consistent with the results of the analysis using the initial classification.^[5]

4. Discussion

With the rapid growth of China's economy, the levels of economic development across different regions show significant imbalance. Previous studies indicate that socioeconomic status of the region can influence the diagnosis and treatment of breast cancer which can affect course and prognosis.^[4,5,18] Our early single-center study in China's Shaanxi Province showed that the occupation and education of patients with breast cancer had a significant impact on TNM staging, clinical and pathological features, implementation of clinical examination, and the selection of treatment patterns.^[9] To further confirm these associations, we conducted this novel multicenter study in which the results confirmed that our previously observed associations also existed across the whole of China.

A number of studies indicate that occurrence and development of breast cancer are closely related to the level of economic income. For example, higher income groups have a higher incidence of early breast cancer diagnosis and a better prognosis. Income level is closely related to occupation and education level.^[9] In this study, we found that the diameters of tumor size of patients in the professional occupation group were smaller, and

Table 5**Multivariable logistic regression for association between individual demographic characteristics and breast cancer stage (stage 0, I, and II, stages III and IV) at diagnosis (including education level).**

Variables	Coefficient	SE	OR	95% CI, lower	95% CI, upper	P
Age at diagnosis, y	-0.003	0.007	0.997	0.984	1.010	.643
BMI	0.059	0.021	1.060	1.017	1.106	.006
Married vs. single	-0.697	0.489	0.498	0.191	1.297	.154
Widowed/divorced vs. single	-1.533	0.789	0.216	0.0459	1.014	.052
Middle and high school vs. primary school and below	-0.190	0.149	0.827	0.617	1.108	.202
University and above vs. primary school and below	-0.557	0.248	0.573	0.352	.932	.025
House wife vs. manual worker	-1.048	0.300	0.350	0.194	.631	.000
Professional vs. manual worker	-0.219	0.201	0.803	0.542	1.191	.275
Private sector worker vs. manual worker	-0.052	0.172	0.949	0.677	1.329	.760
Highest GDP vs. others	0.235	0.853	1.265	0.238	6.721	.782

BMI = body mass index, CI = confidence interval, OR = odds ratio, SE = standard error.

the proportion of early breast cancer at diagnosis was higher, which was similar to the results within the higher educated groups. We and several other groups have previously reported this phenomenon.^[9,19,20]

There are several potential explanations for the observed results. Individuals in a professional occupation and those that are well educated tend to live in more developed cities and subsequently have a higher probability of receiving breast cancer screening.^[21,22] Apart from organizational and funding obstacles, inherent reluctance from cultural barriers and cancer fatalism in Chinese women often hampers screening efforts, particularly in older women.^[23,24] Failure to screen regularly leads to the loss of opportunities for early detection of breast cancer, and as a consequence, increases treatment costs which leads to greater economic burden at a personal and societal level. At present, the early discovery rate of breast cancer in a developing country such as China has large disparities with that of developed countries. Findings from a study in Beijing showed that only 5.2% of new cases were detected by routine mammographic screening, whereas 82.1% of women who were diagnosed had experienced obvious symptoms. Conversely, the proportion of breast cancers detected through screening is about 60% in the United States.^[25,26] This significant delay in diagnosis results in prolonged treatment time of patients, resulting in a worse prognosis. Individuals in professional occupations and those who have received higher education have more possibilities to obtain appropriate medical knowledge; subsequently, they can recognize the symptoms of breast cancer earlier.^[27,28] In addition, they also have sufficient income to access preoperative examination, so implementation rate of their preoperative examination may be higher, and as a consequence, they could find breast cancer earlier. Our study confirmed that the rate of implementation of the relevant presurgery examination was the lowest in manual workers. For education, the highest execution rate was in the higher group of education level of university and above.

Interestingly, in this study, we found that manual laborers had the lowest HR (ER and/or PR) positive rate and the highest HR-negative rate. When considering the impact of education levels on HR rates, the highest HR-positive rate was within the uneducated group. The results of the remaining 4 groups showed that patients with higher education levels exhibited higher HR-positive rate. This result was consistent with reports that breast cancer patients in a better socioeconomic status had a higher proportion of ER-positive.^[29,30] The possible reason is that the occupation and education level are closely related to BMI of patients. Generally, manual laborers in China are more likely to have low BMI because of extensive physical workload. In comparison, patients with higher education levels may have higher BMI because of superior living conditions and lack of time for physical activities.^[31] It is reported that higher BMI is associated with increased risk of HR-positive breast cancer in postmenopausal women.^[32,33] In addition, we also found that uneducated individuals had the highest rate of Her2 negative expression and patients in the group of education level of university and above had the highest HR-negative rate. But at present, we have no reasonable explanations for the findings, and as such it requires further study.

Economic levels, awareness of breast cancer, and the clinical and pathological features of patients can affect the doctors' and patients' choice of treatment patterns. In this study, we found there were significant differences among the different groups when choosing treatment patterns. First, professionals tended to

prefer breast-conserving surgery rather than radical surgery in the operation mode selection. The reason could be that professionals tend to have earlier tumor stage at diagnosis, they can accept new ideas and new technologies easier, and they have perceived higher requirements of quality of life after surgery, which means they are more receptive to sentinel lymph node biopsy and breast-conserving surgery.^[34,35] Manual workers and housewives would delay their treatment because of lower income^[27,36]; therefore the tumor stage is later at diagnosis, so they lose the opportunity for sentinel lymph node biopsy and breast-conserving surgery. In addition, they cannot afford the cost of breast-conserving surgery and postoperative radiotherapy.^[35] Second, people of different occupations had significant differences in the selection of radiotherapy, chemotherapy and endocrine therapy. The implementation rate of radiotherapy and endocrine therapy in the professional group were high which is similar to our previous findings,^[9] but their minimum implementation rate of chemotherapy is somewhat different with our previous works.^[9] The possible reasons include 3 reasons. First, professionals have a higher proportion of breast-conserving surgery and radiation therapy is standard treatment after breast-conserving surgery.^[37,38] Second, professionals have a higher HR-positive rate which results in a higher proportion receiving endocrine therapy. In addition, because endocrine treatment needs spanning for 5 to 10 years, patients' affordability and awareness of the disease can also affect their compliance.^[39] Third, professionals have a high proportion of early breast cancer and subsequently some of them do not require chemotherapy, such as the case with carcinoma *in situ*.^[40]

In this multicenter study, we also found that there were significant differences among breast cancer patients with different education backgrounds regarding their choice of treatment patterns, in which the rate of breast-conserving surgery was highest in the highest education levels. The opposite trend was observed for radical surgery. In addition, we found that the highest implementation rate of breast-conserving surgery was only 8.6%, which is still significantly lower than within the United States and other developed countries. At present, lymph node biopsy and breast-conserving surgery have become the main treatments for breast cancer in developed countries^[41,42] with a rate of >50% in the United States, >30% in Japan, and 70% to 80% in Singapore.^[9,43] Such findings suggest that we should further intensify breast-conserving surgery so that more patients can benefit from advanced surgical treatment.

This study also exhibits some shortcomings. First, the hospital and month may unavoidably exhibit some degree of selection bias. Second, there are some serious missing data such as lost education information in Beijing, which will have some impact on the conclusions. To weaken the influence of missing data, we conducted 2 multivariate analyses without or with education status information. We found that occupation and education were independent factors affecting the TNM staging at diagnosis. And the results were to a certain extent convincing; what is most regrettable is that there are no follow-up clinical data which are very limited for study of the prognosis. We plan to collect the follow-up data in a future study. But after all, this is the first nationwide representative clinical research on breast cancer.

In summary, the prognosis of breast cancer patients is affected by the stage at diagnosis and standard of treatment patterns. This study showed that occupation and education have a significant impact on these 2 key prognostic factors, suggesting efforts should be made to address imbalances across different

socioeconomic groups. This could be addressed through increases in regular breast cancer screening programs among individuals with lower-income occupations or lower education levels and improve the coverage and penetration of screening to improve early detection rate. Second, there is a need to strengthen publicity of breast cancer-related knowledge for lower-income occupational groups or those with lower education levels to enable them to better understand the importance of recognizing early clinical symptoms and treatment options. The results of this study also suggest that changes regarding health insurance policy may be necessary with the proportion of reimbursements needing to be higher for those with lower-income occupations or lower education levels so to ensure they do not encounter financial barriers that stop them from reporting their symptoms earlier and subsequently receiving more timely and comprehensively treatment. These recommendations are also significant for other developing countries.

5. Conclusions

We found that occupation and education level have a significant impact on the TNM staging, clinical and pathological features, implementation of examination, and the selection of treatment patterns and occupation and education level of patient are independent factors for TNM staging at diagnosis. These suggest that the government should focus on characteristics of lower-income occupation and lower educational attainment group to develop more accurate and effective prevention and treatment strategies for breast cancer.

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