

External Supports Are Associated With the COVID-19 Vaccination in Chinese Breast Cancer Patients: A Cross-Sectional Survey

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Abstract

Background: Coronavirus disease 2019 (COVID-19) is a global pandemic. Breast cancer is the most commonly diagnosed malignant cancer in China. Considering the specific national conditions, no evidence is available for factors associated with COVID-19 vaccination in patients with breast cancer.

Methods: This was a cross-sectional survey, fielded from June 21 through June 27, 2021. A total of 944 nationally representative samples of Chinese breast cancer patients participating in the survey were included. Participant surveys included questions addressing who finished COVID-19 vaccination with the question “Have you taken the COVID-19 vaccine?”, and response options were “Yes” and “No”.

Results: Overall, 730 (77.33%) women with breast cancer were unvaccinated, and only 214 (22.67%) were vaccinated with the COVID-19 vaccine. After adjusting for potential confounders, including both sociodemographic and clinical characteristics, we found that external support, including positive doctor suggestions (odds ratio (OR): 5.52; 95% confidence interval (CI): 3.50 - 8.71; $P < 0.0001$), positive support from surrounding people (OR: 11.65; 95% CI: 7.57 - 17.91; $P < 0.0001$), and negative initiative from the community (OR:

0.15; 95% CI: 0.06 - 0.35; $P < 0.0001$), was associated with COVID-19 vaccination rates among breast cancer patients. These results remain stable in subgroup analyses. We found that most participants (82.52%) understood the necessity of COVID-19 vaccinations in China was strong; however, the recognition regarding the COVID-19 vaccine showed different patterns between vaccinated and unvaccinated participants.

Conclusions: Our findings suggest external support, including vaccination suggestions from surgeons or oncologists, vaccination suggestions from associated people, and residents’ committee mandated vaccinations, was associated with the COVID-19 vaccination rates. Interventions regarding these factors and improving publicity as well as education regarding COVID-19 vaccines among breast cancer patients are warranted.

Keywords: Breast cancer patients; COVID-19 vaccination; External supports

Introduction

As of late June 2021, over 178 million patients with coronavirus disease 2019 (COVID-19) have been diagnosed globally, including approximately 3.9 million deaths [1]. The ongoing COVID-19 pandemic poses tremendous hazards to public health and results in devastating medical, economic and social consequences. At present, medications (e.g., remdesivir, hydroxychloroquine, lopinavir, and interferon regimens) have inconsistent effects on overall mortality, initiation of ventilation, and length of stay for inpatients with COVID-19, except for dexamethasone which can help reduce the duration on a ventilator and save the lives of patients with serious and critical disease [2]. The most promising strategy to prevent COVID-19 incidence and mortality is the vaccination of COVID-19 worldwide. To date, over 2.4 billion vaccine doses have been administered, as reported by the World Health Organization (WHO).

Several studies have revealed that patients with malignancy are of the vulnerable population to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and have a higher mortality rate than patients without cancer among in-

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patients with COVID-19 [3-6]. Some of these patients have delayed diagnosis and treatment of the disease due to the fear of the COVID-19 pandemic, which in turn affects the survival rate of patients [7]. Data are limited on the safety and efficacy of the COVID-19 vaccine in patients with malignancy because most registration trials include patients without a history of any cancer [8]. Several small studies have shown that the levels of SARS-CoV-2 neutralizing antibodies in patients with cancer treated with immune checkpoint inhibitors are significantly lower than those in healthy volunteers, despite the similar short-term safety of the mRNA vaccines in both groups [9-12].

Female breast cancer has become the most commonly diagnosed malignant tumor worldwide, and the estimated number of Chinese breast cancer incident cases is approximately 416,000 in 2020 [13]. A previous survey shows that 13% of breast cancer patients have been vaccinated and 30% of patients are hesitant to be vaccinated for reasons of mistrust in the health care system, misconception, poor educational attainment, and so on [14].

As most people have been encouraged to receive COVID-19 vaccination and over one billion COVID-19 vaccination doses have now been administered in China, we conducted an online investigation to survey the COVID-19 vaccination in Chinese breast cancer patients who have undergone surgery and analyze factors influencing their vaccination. The present study may help health care policy-makers in China and other countries improve patient education and vaccination policies in patients with breast cancer.

Materials and Methods

Study design and participants

This was a cross-sectional study to survey the factors influencing COVID-19 vaccination in Chinese breast cancer patients. The questionnaire was designed using www.sojump.com and could only be submitted upon completion of all questions. Breast cancer patients who visited the WeChat public platform named "Dr. Wang Jing, Cancer Hospital, Chinese Academy of Medical Sciences", sharing knowledge of breast disease with a total of 32,271 followers from different regions of China, were invited to complete the web-based survey, with only one WeChat ID being submitted per person for the questionnaire. First, we pretested 66 patients on June 20, 2021 to assure high standards of data quality. Then, we improved the questions and ran the questionnaire from June 21, 2021 to June 27, 2021. Finally, a total of 4,849 followers received the notice of our questionnaire; of these, 944 breast cancer patients finished the questionnaire. All information of participants was kept anonymous with the understanding that this information could be used for scientific research.

Measures

Participant demographics in our questionnaire included age, employment (yes or no), yearly personal income ($\geq 50,000$

or $< 5,000$), marital status (married or unmarried), region of residency in China (North China, East China, Northeast China, Central China, South China, West China or others), place of residence (urban or rural), education level (higher than high school or high school and lower), influenza vaccination history (never, at least once in 3 years or at least once in 10 years), personal COVID-19 history (yes or no) and COVID-19 vaccination status (yes or no). Medical history information included time after surgery (date of surgery), surgical methods (mastectomy or breast-conserving surgery), neoadjuvant therapy (yes or no), anti-human epidermal growth factor receptor type 2 (HER2) therapy (yes or no), chemotherapy (yes or no), endocrine therapy (yes or no), radiotherapy (yes or no), undergoing treatment (yes or no), current treatment method (no treatment, endocrine therapy, others (chemotherapy, anti-HER2 therapy, radiotherapy, or combined treatment like endocrine therapy with anti-HER2 therapy) or traditional Chinese medicine) and recurrence of breast cancer before vaccination (yes or no).

Furthermore, we collected some external support information on the COVID-19 vaccination, including vaccination suggestions from surgeons or oncologists (indefinite suggestion, no communication with doctors, recommended, not recommended), vaccination suggestions from around people (no suggestion, recommended or not recommended) and calls for vaccination by the residents' committees or employers (yes, no vaccinal notice or no).

To explore potential reasons for unvaccinated participants, we also assessed the subjective factors in unvaccinated participants with questions, "Do you believe COVID-19 vaccination may cause special side effects to breast cancer patients?", "Do you believe vaccination may lead to recurrence of breast cancer?" and "Do you believe the COVID-19 vaccine is safe?", followed by the response options "I don't know", "Yes" and "No". We asked, "Do you believe breast cancer patients can be inoculated with COVID-19 vaccine?", followed by the response options "I don't know", "Yes", "No" and "Depend on current treatment". We asked, "Do you believe the necessity of COVID-19 vaccination in China is strong or weak?"; response options were "Strong" and "Weak".

Statistical analysis

Baseline characteristics of participants were summarized by percentages and frequencies. Because the percentage of missing data was minor (0-0.4%), no imputation was performed [15]. The Kruskal-Wallis (for skewed distribution) test, one-way analysis of variance (ANOVA) (for normal distribution), and Chi-square tests (for categorical variables) were used to examine any differences between the proportions and means of the groups. We used a linear regression model to explore potential associations between variables and COVID-19 vaccination among the study population. Following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [16], we simultaneously reported the effect size of exposures in separate models, including a crude model, minimally adjusted model and a fully adjusted model. Confounders were selected based on their associations with the outcomes or a change in effect estimate of more than 10%

[17]. We further used stratified linear regression models to explore the association of exposures and outcomes in subgroup analyses. We examined any modification and interaction of subgroups by the likelihood ratio test. All analyses were performed using the statistical software R (<http://www.R-project.org>) and EmpowerStats platform (<http://www.empowerstats.com>). $P < 0.05$ was considered statistically significant (two-sided).

Ethical considerations

The Research Ethics Committee of National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences approved the study. The study was conducted in compliance with the ethical standards of the responsible institution on human subjects as well as with the Helsinki Declaration. Informed consent was waived because the research was deemed to be of minimal risk and no identifiable data were collected.

Results

Characteristics of participants

All results presented here are based on the 944 participants who responded to the questionnaire. Of these, 730 (77.33%) women with breast cancer were unvaccinated, and less than one-third (22.67%) were vaccinated with the COVID-19 vaccine. The average age of the participants was 49.05 ± 8.84 years old. The baseline characteristics of the participants are listed in Table 1. We found no statistically significant difference in age, previous treatment methods (surgical method, anti-HER2 therapy, breast reconstruction surgery, endocrine therapy, and neoadjuvant therapy), personal COVID-19 history, current therapy, educational level, employment, marital status, region of living in China, and place of residence or recurrence of breast cancer before vaccination between participants who were vaccinated or unvaccinated. Compared with the vaccinated participants, unvaccinated participants had significant differences in time after surgery, axillary lymph node dissection (ALND), chemotherapy, influenza vaccination history, yearly personal income (Chinese Yuan), external support, including vaccination suggestions from surgeons or oncologists, vaccination suggestions from around people, and vaccination suggestions from residents' committees or employers.

Univariate analysis results

Through univariate analysis, we found time after surgery, ALND, chemotherapy, influenza vaccination history, yearly personal income (Chinese Yuan), and external support (vaccination suggestion from surgeon or oncologist, vaccination suggestion from associated people, and calls for vaccination by the residents' committees or employers). Age, previous treatment methods (surgical method, anti-HER2 therapy, breast

reconstruction surgery, endocrine therapy, and neoadjuvant therapy), personal COVID-19 history, current therapy, educational level, employment, marital status, region of living in China, and place of residence and recurrence of breast cancer before vaccination were not associated with COVID-19 vaccination. All results are listed in Table 2.

Association between external support and COVID-19 vaccination

To identify potential key factors influencing COVID-19 vaccination among breast cancer patients, we further used a linear regression model to estimate the association between external support and COVID-19 vaccination. The results of the crude model, minimally adjusted model and fully adjusted model are shown in Table 3. Compared with participants receiving indefinite vaccination suggestions from surgeons or oncologists, participants who received recommended suggestions were positively correlated with COVID-19 vaccination (OR: 5.52; 95% CI: 3.50 - 8.71; $P < 0.0001$), while participants who did not receive recommended suggestions were negatively correlated with COVID-19 vaccination (OR: 0.36; 95% CI: 0.16 - 0.79; $P = 0.0107$). Compared with participants with no recommended suggestion from around people, participants who received recommended suggestions were positively correlated with COVID-19 vaccination (OR: 11.65; 95% CI: 7.57 - 17.91; $P < 0.0001$). Compared with participants who were asked to be vaccinated by the residents' committee or employer, participants who were not asked (OR: 0.15; 95% CI: 0.06 - 0.35; $P < 0.0001$) or without vaccinal notice (OR: 0.26; 95% CI: 0.16 - 0.42; $P < 0.0001$) were negatively associated with COVID-19 vaccination. These results remain stable in the crude model, minimally adjusted model and fully adjusted model. We further explored the association between external support and COVID-19 vaccination in subgroup analyses, and we found no interaction between external support and age, time after surgery, ALND, or year personal income (Table 4; P values for interactions were > 0.05).

Recognitions of breast cancer patients regarding COVID-19 vaccine

To identify potential concerns regarding COVID-19 vaccination among unvaccinated breast cancer patients, we further show the recognition of COVID-19 vaccination in Table 5. For the 730 unvaccinated breast cancer patients, most of the participants (81.10%) expressed "I don't know" regarding whether COVID-19 vaccination may cause special side effects to breast cancer patients, and only a minority of participants (1.51%) believed breast cancer patients could be inoculated with the COVID-19 vaccine. Most of the participants (78.36%) were unsure about whether COVID-19 vaccination may lead to reoccurrence of breast cancer. More than half of the participants (51.37%) were unsure or concerned about the safety of the COVID-19 vaccine. Interestingly, even for unvaccinated breast cancer patients, most of the participants (79.45%) also

Table 1. Characteristics of Study Population

	Unvaccinated	Vaccinated	P-value
No.	730	214	
Age (years)	48.78 ± 8.74	50.00 ± 9.12	0.075
Time after surgery (days)	910.92 ± 681.51	1,272.64 ± 883.51	< 0.001
Surgical method			0.497
Mastectomy	452 (61.92%)	127 (59.35%)	
Breast conserving surgery	278 (38.08%)	87 (40.65%)	
Axillary lymph node dissection			< 0.001
Yes	403 (55.21%)	81 (37.85%)	
No	327 (44.79%)	133 (62.15%)	
Breast reconstruction surgery			0.305
No	659 (90.27%)	188 (87.85%)	
Yes	71 (9.73%)	26 (12.15%)	
Anti-HER2 therapy			0.081
No	563 (77.12%)	177 (82.71%)	
Yes	167 (22.88%)	37 (17.29%)	
Chemotherapy			< 0.001
Yes	503 (68.90%)	120 (56.07%)	
No	227 (31.10%)	94 (43.93%)	
Endocrinotherapy			0.984
Yes	594 (81.37%)	174 (81.31%)	
No	136 (18.63%)	40 (18.69%)	
Radiotherapy			0.047
Yes	441 (60.41%)	113 (52.80%)	
No	289 (39.59%)	101 (47.20%)	
Neoadjuvant therapy			0.062
No	630 (86.30%)	195 (91.12%)	
Yes	100 (13.70%)	19 (8.88%)	
Undergoing treatment			0.085
Yes	480 (65.75%)	127 (59.35%)	
No	250 (34.25%)	87 (40.65%)	
Current treatment method			< 0.001
No treatment	250 (34.25%)	87 (40.65%)	
Endocrinotherapy	307 (42.05%)	109 (50.93%)	
Others	158 (21.64%)	17 (7.94%)	
Traditional Chinese medicine	15 (2.05%)	1 (0.47%)	
Recurrence of breast cancer before vaccination			0.282
No	706 (96.71%)	210 (98.13%)	
Yes	24 (3.29%)	4 (1.87%)	
Personal COVID-19 history			0.45
No	718 (98.36%)	212 (99.07%)	
Yes	12 (1.64%)	2 (0.93%)	

Table 1. Characteristics of Study Population - (continued)

	Unvaccinated	Vaccinated	P-value
Educational level			0.923
Higher than high school	504 (69.04%)	147 (68.69%)	
High school and lower	226 (30.96%)	67 (31.31%)	
Employment status			0.153
Yes	386 (52.88%)	125 (58.41%)	
No	344 (47.12%)	89 (41.59%)	
Influenza vaccination history			< 0.001
Never	617 (84.52%)	162 (75.70%)	
At least once in 3 years	61 (8.36%)	39 (18.22%)	
At least once in 10 years	52 (7.12%)	13 (6.07%)	
Yearly personal income (Chinese Yuan)			0.012
≥ 50,000	397 (54.38%)	137 (64.02%)	
< 5,0000	333 (45.62%)	77 (35.98%)	
Marital status			0.759
Married	639 (87.53%)	189 (88.32%)	
Unmarried	91 (12.47%)	25 (11.68%)	
Region of living in China			0.056
North China	445 (60.96%)	136 (63.55%)	
East China	118 (16.16%)	32 (14.95%)	
Northeast China	66 (9.04%)	19 (8.88%)	
Central China	37 (5.07%)	9 (4.21%)	
South China	28 (3.84%)	12 (5.61%)	
West China	36 (4.93%)	4 (1.87%)	
Others	0 (0.00%)	2 (0.93%)	
Place of residence			0.611
Urban area	653 (89.45%)	194 (90.65%)	
Rural area	77 (10.55%)	20 (9.35%)	
Vaccination suggestion from surgeon or oncologist			< 0.001
Indefinite suggestion	319 (43.70%)	81 (37.85%)	
No communication with doctors	231 (31.64%)	40 (18.69%)	
Recommended	60 (8.22%)	85 (39.72%)	
Not recommended	120 (16.44%)	8 (3.74%)	
Vaccination suggestion from around people			< 0.001
No suggestion	398 (54.52%)	36 (16.82%)	
Recommended	161 (22.05%)	168 (78.50%)	
Not recommended	171 (23.42%)	10 (4.67%)	
Calls for vaccination by the residents' committee or employer			< 0.001
Yes	407 (55.75%)	184 (85.98%)	
No vaccinal notice	213 (29.18%)	24 (11.21%)	
No	110 (15.07%)	6 (2.80%)	

HER2: human epidermal growth factor receptor type 2; COVID-19: coronavirus disease 2019.

Table 2. Univariate Analysis of Factors Associated With COVID-19 Vaccination Among Breast Cancer Patients

	Statistics	OR (95% CI)	P-value
Age (years)	49.05 ± 8.84	1.02 (1.00 - 1.03)	0.0751
Time after surgery			
Q1	235 (25.00%)	1	
Q2	233 (24.79%)	1.35 (0.82 - 2.24)	0.2366
Q3	236 (25.11%)	2.02 (1.25 - 3.26)	0.0039
Q4	236 (25.11%)	3.38 (2.13 - 5.35)	< 0.0001
Surgical method			
Mastectomy	579 (61.33%)	1	
Breast conserving surgery	365 (38.67%)	1.11 (0.82 - 1.52)	0.497
Axillary lymph node dissection			
Yes	484 (51.27%)	1	
No	460 (48.73%)	2.02 (1.48 - 2.77)	< 0.0001
Breast reconstruction surgery			
No	847 (89.72%)	1	
Yes	97 (10.28%)	1.28 (0.80 - 2.07)	0.3055
Anti-HER2 therapy			
No	740 (78.39%)	1	
Yes	204 (21.61%)	0.70 (0.48 - 1.05)	0.0818
Chemotherapy			
Yes	623 (66.00%)	1	
No	321 (34.00%)	1.74 (1.27 - 2.37)	0.0005
Endocrinotherapy			
Yes	768 (81.36%)	1	
No	176 (18.64%)	1.00 (0.68 - 1.48)	0.9838
Radiotherapy			
Yes	554 (58.69%)	1	
No	390 (41.31%)	1.36 (1.00 - 1.85)	0.0473
Neoadjuvant therapy			
No	825 (87.39%)	1	
Yes	119 (12.61%)	0.61 (0.37 - 1.03)	0.0639
Current treatment			
Yes	607 (64.30%)	1	
No	337 (35.70%)	1.32 (0.96 - 1.80)	0.0858
Current treatment method			
No treatment	337 (35.70%)	1	
Endocrine	416 (44.07%)	1.02 (0.74 - 1.42)	0.9045
Others	175 (18.54%)	0.31 (0.18 - 0.54)	< 0.0001
Traditional Chinese medicine	16 (1.69%)	0.19 (0.02 - 1.47)	0.1122
Recurrence of breast cancer before vaccination			
No	916 (97.03%)	1	
Yes	28 (2.97%)	0.56 (0.19 - 1.63)	0.2885
Personal COVID-19 history			
No	930 (98.52%)	1	

Table 2. Univariate Analysis of Factors Associated With COVID-19 Vaccination Among Breast Cancer Patients - (continued)

	Statistics	OR (95% CI)	P-value
Yes	14 (1.48%)	0.56 (0.13 - 2.54)	0.4563
Educational level			
Higher than high school	651 (68.96%)	1	
High school or lower	293 (31.04%)	1.02 (0.73 - 1.41)	0.9226
Employment status			
Yes	511 (54.13%)	1	
No	433 (45.87%)	0.80 (0.59 - 1.09)	0.1535
Influenza vaccination history			
Never	779 (82.52%)	1	
At least once in 3 years	100 (10.59%)	2.44 (1.57 - 3.77)	< 0.0001
At least once in 10 years	65 (6.89%)	0.95 (0.51 - 1.79)	0.8791
Yearly personal income (Chinese Yuan)			
≥ 50,000	534 (56.57%)	1	
< 5,0000	410 (43.43%)	0.67 (0.49 - 0.92)	0.0127
Marital status			
Married	828 (87.71%)	1	
Unmarried	116 (12.29%)	0.93 (0.58 - 1.49)	0.7589
Region of living in China			
North China	581 (61.55%)	1	
East China	150 (15.89%)	0.89 (0.57 - 1.37)	0.5904
Northeast China	85 (9.00%)	0.94 (0.55 - 1.62)	0.8298
Central China	46 (4.87%)	0.80 (0.37 - 1.69)	0.5526
South China	40 (4.24%)	1.40 (0.69 - 2.83)	0.3458
West China	40 (4.24%)	0.36 (0.13 - 1.04)	0.0591
Others	2 (0.21%)	NA	NA
Place of residence			
Urban area	847 (89.72%)	1	
Rural area	97 (10.28%)	0.87 (0.52 - 1.47)	0.6108
Vaccination suggestion from surgeon or oncologist			
Indefinite suggestion	400 (42.37%)	1	
No communication with doctors	271 (28.71%)	0.68 (0.45 - 1.03)	0.0706
Recommended	145 (15.36%)	5.58 (3.70 - 8.41)	< 0.0001
Not recommended	128 (13.56%)	0.26 (0.12 - 0.56)	0.0005
Vaccination suggestion from around people			
No suggestion	434 (45.97%)	1	
Recommended	329 (34.85%)	11.54 (7.70 - 17.28)	< 0.0001
Not recommended	181 (19.17%)	0.65 (0.31 - 1.33)	0.2372
Calls for vaccination by the residents' committee or employer			
Yes	591 (62.61%)	1	
No vaccinal notice	237 (25.11%)	0.25 (0.16 - 0.39)	< 0.0001
No	116 (12.29%)	0.12 (0.05 - 0.28)	< 0.0001

HER2: human epidermal growth factor receptor type 2; COVID-19: coronavirus disease 2019; OR: odds ratio; CI: confidence interval.

Table 3. Relationship Between External Supports and COVID-19 Vaccination in Different Models

Exposure	Crude model (OR (95% CI), P-value)	Minimally adjusted model (OR (95% CI), P-value)	Fully adjusted model (OR (95% CI), P-value)
Vaccination suggestion from surgeon or oncologist			
Indefinite suggestion	Ref	Ref	Ref
No communication with doctors	0.68 (0.45 - 1.03), 0.0706	0.68 (0.45 - 1.04), 0.0757	0.80 (0.52 - 1.24), 0.3149
Recommended	5.58 (3.70 - 8.41), < 0.0001	5.44 (3.57 - 8.27), < 0.0001	5.52 (3.50 - 8.71), < 0.0001
Not recommended	0.26 (0.12 - 0.56), 0.0005	0.27 (0.12 - 0.57), 0.0007	0.36 (0.16 - 0.79), 0.0107
Vaccination suggestion from around people			
No suggestion	Ref	Ref	Ref
Recommended	11.54 (7.70 - 17.28), < 0.0001	11.37 (7.58 - 17.06), < 0.0001	11.65 (7.57 - 17.91), < 0.0001
Not recommended	0.65 (0.31 - 1.33), 0.2372	0.64 (0.31 - 1.32), 0.2262	0.66 (0.31 - 1.42), 0.2885
Calls for vaccination by the residents' committee or employer			
Yes	Ref	Ref	Ref
No vaccinal notice	0.25 (0.16 - 0.39), < 0.0001	0.25 (0.16 - 0.40), < 0.0001	0.26 (0.16 - 0.42), < 0.0001
No	0.12 (0.05 - 0.28), < 0.0001	0.12 (0.05 - 0.28), < 0.0001	0.15 (0.06 - 0.35), < 0.0001

Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age; yearly personal income; educational level; employment status. Fully adjusted model: we adjusted for age; time after surgery; surgical method; axillary lymph node dissection; breast reconstruction surgery; anti-HER2 therapy; chemotherapy; endocrinotherapy; radiotherapy; neoadjuvant therapy; undergoing treatment; recurrence of breast cancer before vaccination; personal COVID-19 history; educational level; employment; influenza vaccination history; yearly personal income; marital status; region of living in China; place of residence. OR: odds ratio; CI: confidence interval; Ref: reference.

Table 4. Effect Size of External Supports on COVID-19 Vaccination in Prespecified and Exploratory Subgroups

Variables	No.	OR (95% CI), P-value	No.	OR (95% CI), P-value	P for interaction
Vaccination suggestion from surgeon or oncologist					
Age dichotomous	Age = low		Age = high		0.922
Indefinite suggestion	157	1	243	1	
No communication with doctors	142	0.76 (0.38 - 1.51), 0.4299	129	0.86 (0.48 - 1.57), 0.6324	
Recommended	68	5.35 (2.58 - 11.10), < 0.0001	77	6.20 (3.31 - 11.62), < 0.0001	
Not recommended	68	0.39 (0.13 - 1.14), 0.0859	60	0.26 (0.07 - 0.91), 0.0350	
Time after surgery = short					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
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Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
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Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
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Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
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Indefinite suggestion	179	1	218	1	0.201
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Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
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Indefinite suggestion	179	1	218	1	0.201
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Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
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Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
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Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04), 0.4749	43	0.21 (0.06 - 0.76), 0.0178	
Time after surgery = long					
Indefinite suggestion	179	1	218	1	0.201
No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124	0.63 (0.35 - 1.14), 0.1289	
Recommended	58	12.36 (5.35 - 28.57), < 0.0001	87	4.56 (2.46 - 8.46), < 0.0001	
Not recommended	85	0.67 (0.22 - 2.04),			

Table 4. Effect Size of External Supports on COVID-19 Vaccination in Prespecified and Exploratory Subgroups - (continued)

Variables	No.	OR (95% CI), P-value	No.	OR (95% CI), P-value	P for interaction
Indefinite suggestion	209	1	191	1	
No communication with doctors	146	0.89 (0.45 - 1.78), 0.7412	125	0.74 (0.41 - 1.33), 0.3151	
Recommended	63	5.84 (2.81 - 12.14), <0.0001	82	5.89 (3.17 - 10.95), <0.0001	
Not recommended	66	0.54 (0.17 - 1.68), 0.2867	62	0.23 (0.07 - 0.71), 0.0104	
Chemotherapy = yes			Chemotherapy = no		0.331
Indefinite suggestion	246	1	154	1	
No communication with doctors	188	0.69 (0.37 - 1.27), 0.2288	83	0.81 (0.41 - 1.60), 0.5405	
Recommended	94	6.79 (3.62 - 12.74), <0.0001	51	3.19 (1.51 - 6.73), 0.0024	
Not recommended	95	0.41 (0.15 - 1.16), 0.0927	33	0.23 (0.06 - 0.88), 0.0320	
Yearly personal income ≥ 50,000			Yearly personal income < 50,000		0.927
Indefinite suggestion	216	1	184	1	
No communication with doctors	152	0.72 (0.41 - 1.29), 0.2750	119	0.88 (0.43 - 1.80), 0.7174	
Recommended	100	5.68 (3.21 - 10.05), <0.0001	45	5.66 (2.44 - 13.14), <0.0001	
Not recommended	66	0.28 (0.09 - 0.84), 0.0234	62	0.45 (0.13 - 1.48), 0.1868	
Vaccination suggestion from around people					
Age dichotomous			Age = high		0.600
No suggestion	205	1	229	1	
Recommended	141	12.58 (6.36 - 24.88), <0.0001	188	12.85 (7.01 - 23.56), <0.0001	
Not recommended	89	0.90 (0.32 - 2.55), 0.8409	92	0.41 (0.12 - 1.46), 0.1687	
Time after surgery = short			Time after surgery = long		0.853
No suggestion	217	1	216	1	
Recommended	149	13.90 (6.30 - 30.67), <0.0001	179	11.78 (6.72 - 20.65), <0.0001	
Not recommended	102	0.56 (0.14 - 2.21), 0.4052	77	0.68 (0.26 - 1.79), 0.4343	
Axillary lymph node dissection = yes			Axillary lymph node dissection = no		0.241
No suggestion	235	1	199	1	
Recommended	142	8.27 (4.38 - 15.64), <0.0001	187	17.19 (9.15 - 32.30), <0.0001	
Not recommended	107	0.40 (0.11 - 1.44), 0.1607	74	0.97 (0.36 - 2.63), 0.9491	
Chemotherapy = yes			Chemotherapy = no		0.907
No suggestion	302	1	132	1	
Recommended	191	12.16 (6.72 - 22.02), <0.0001	138	12.77 (6.09 - 26.80), <0.0001	
Not recommended	130	0.59 (0.21 - 1.66), 0.3166	51	0.84 (0.25 - 2.84), 0.7794	

Table 4. Effect Size of External Supports on COVID-19 Vaccination in Prespecified and Exploratory Subgroups - (continued)

Variables	No.	OR (95% CI), P-value	No.	OR (95% CI), P-value	P for interaction
Yearly personal income ≥ 50,000	235	1	Yearly personal income < 50,000	199	0.736
No suggestion	202	13.78 (7.73 - 24.57), < 0.0001	1	10.47 (5.20 - 21.08), < 0.0001	
Recommended	97	0.79 (0.30 - 2.10), 0.6396	84	0.45 (0.12 - 1.70), 0.2375	
Not recommended	Calls for vaccination by the residents' committee or employer				
Age dichotomous					
Age = low	293	1	Age = high	298	0.421
Yes	87	0.37 (0.18 - 0.79), 0.0104	150	0.19 (0.10 - 0.38), < 0.0001	
No vaccinal notice	55	0.12 (0.03 - 0.53), 0.0050	61	0.16 (0.05 - 0.46), 0.0008	
No	Time after surgery = short				
Yes	282	1	Time after surgery = long	308	0.283
No vaccinal notice	115	0.18 (0.07 - 0.44), 0.0002	120	0.26 (0.14 - 0.48), < 0.0001	
No	71	0.05 (0.01 - 0.36), 0.0034	44	0.22 (0.08 - 0.61), 0.0036	
Axillary lymph node dissection = yes					
Yes	274	1	Axillary lymph node dissection = no	317	0.331
No vaccinal notice	140	0.28 (0.13 - 0.58), 0.0006	97	0.18 (0.08 - 0.37), < 0.0001	
No	70	0.23 (0.08 - 0.69), 0.0090	46	0.07 (0.01 - 0.29), 0.0004	
Chemotherapy = yes					
Yes	370	1	Chemotherapy = no	221	0.801
No vaccinal notice	165	0.30 (0.16 - 0.58), 0.0004	72	0.21 (0.09 - 0.49), 0.0003	
No	88	0.15 (0.05 - 0.45), 0.0007	28	0.15 (0.03 - 0.69), 0.0150	
Yearly personal income ≥ 50,000					
Yes	367	1	Yearly personal income < 50,000	224	0.932
No vaccinal notice	107	0.23 (0.12 - 0.46), < 0.0001	130	0.25 (0.12 - 0.54), 0.0004	
No	60	0.12 (0.04 - 0.40), 0.0006	56	0.17 (0.05 - 0.60), 0.0059	

Above model adjusted for age; time after surgery; surgical method; axillary lymph node dissection; breast reconstruction surgery; anti-HER2 therapy; chemotherapy; endocrinotherapy; radiotherapy; neoadjuvant therapy; undergoing treatment; recurrence of breast cancer before vaccination; personal COVID-19 history; educational level; employment; influenza vaccination history; yearly personal income; marital status; region of living in China; place of residence. In each case, the model is not adjusted for the stratification variable. OR: odds ratio; CI: confidence interval; HER2: human epidermal growth factor receptor type 2.

Table 5. Recognitions of Breast Cancer Patients Regarding COVID-19 Vaccination

	Unvaccinated	Vaccinated	OR (95% CI)	P-value
No.	730	214		
Do you believe COVID-19 vaccination may cause special side effect to breast cancer patients?			1.17 (1.01 - 1.33)	< 0.001
I don't know	592 (81.10%)	98 (45.79%)		
No	53 (7.26%)	112 (52.34%)		
Yes	85 (11.64%)	4 (1.87%)		
Do you believe breast cancer patients can be inoculated with COVID-19 vaccine?			0.73 (0.57 - 0.89)	< 0.001
No	284 (38.90%)	53 (24.77%)		
Depend on current treatment	189 (25.89%)	108 (50.47%)		
I don't know	246 (33.70%)	33 (15.42%)		
Yes	11 (1.51%)	20 (9.35%)		
Do you believe the necessity of COVID-19 vaccination in China is strong or weak?			0.40 (0.25 - 0.55)	< 0.001
Strong	580 (79.45%)	199 (92.99%)		
Weak	150 (20.55%)	15 (7.01%)		
Do you believe vaccination may lead to recurrence of breast cancer?			1.02 (0.86 - 1.18)	< 0.001
I don't know	572 (78.36%)	74 (34.58%)		
No	147 (20.14%)	139 (64.95%)		
Yes	11 (1.51%)	1 (0.47%)		
Do you believe the COVID-19 vaccine is safe?			0.74 (0.59 - 0.90)	< 0.001
Yes	355 (48.63%)	175 (81.78%)		
No or I don't know	375 (51.37%)	39 (18.22%)		

COVID-19: coronavirus disease 2019; OR: odds ratio; CI: confidence interval.

believed in the need for vaccinations against COVID-19 in China to be strong. We found recognitions regarding the COVID-19 vaccine showed different patterns between vaccinated and unvaccinated participants (Table 5).

Discussion

Previous surveys studied factors influencing attitudes on COVID-19 vaccination among the general populations and showed that 71.5% of participants would be likely to take the COVID-19 vaccine [18]. Only two studies have reported attitudes and factors associated with COVID-19 vaccine hesitancy in the special population of those who are patients with malignancy. One study from Mexico reported that 12.76% of breast cancer patients had received COVID-19 vaccination, 57.67% were willing to be vaccinated immediately [14], and another study determined the rate of willingness to get vaccinated was 60.3% [19]. However, people's willingness to receive the COVID-19 vaccine might not be a good predictor of acceptance, while decisions regarding COVID-19 vaccination are multifactorial and can shift over time. In the present study, only 26.87% of patients who received notice of COVID-19 vaccination were vaccinated.

Chinese cases of breast cancer account for nearly 20% of the world cases in 2020 according to the WHO. Considering the national conditions of COVID-19 prevention and control in China, we evaluated the relationship between external support and COVID-19 vaccination among breast cancer patients. As shown in the fully adjusted model, the present study is the first to suggest a strong association between external support (vaccination suggestions from surgeons or oncologists, vaccination suggestions from associated people, and calls for vaccination by the residents' committees or employers) and COVID-19 vaccination in patients with malignancy, with these results remaining stable in subgroup analyses. Furthermore, two out of these three factors can be easy to intervene. Positive vaccination suggestions from surgeons or oncologists and more appeals by the residents' committees or employers would contribute to increased COVID-19 vaccination rates in patients with breast cancer.

Similar to previous studies [14, 18, 20, 21], the present study shows that patients with higher personal income and higher previous influenza vaccinations prefer to take the COVID-19 vaccine. In addition, this is the first study to adjust for potential confounding factors of patient treatment methods. We found that there was a lower vaccination rate in patients with a shorter period after surgery who underwent ALND, chemotherapy and radiotherapy. More patients undergoing only endocrine therapy and no adjuvant treatment are vaccinated than patients undergoing other treatments and/or combined treatments.

Additionally, patient education is another factor associated with vaccination. Our findings suggest that even if most participants agree that it is necessary for COVID-19 vaccination, concerns including side effects specific to breast cancer patients, safety of the COVID-19 vaccine, and potential for recurrence of breast cancer may be potential factors that hinder them from COVID-19 vaccination.

The present study has several strengths. First, this is the first study reporting that external support is associated with COVID-19 vaccination in breast cancer patients. Second, we used a large nationally representative sample of breast cancer patients in China, therefore allowing the generation of our findings in China. Third, one important feature of these external supports is that these factors are intervenable, thus improving their clinical value. Fourth, strict statistical adjustment was used to minimize potential confounding factors, including both sociodemographic and clinical characteristics, while previous studies only considered sociodemographic factors. Despite the cross-sectional nature of this study, we provide needed evidence to understand factors associated with COVID-19 vaccination among breast cancer patients in China.

Conclusions

Overall, we found that most of the breast cancer patients had not completed their COVID-19 vaccinations. We identified strong associations between external support (vaccination suggestions from surgeon/oncologist and associated people and calls for vaccinations by the residents' committees or employers) and COVID-19 vaccination. Even if most participants agree that it is necessary to finish COVID-19 vaccination, personal concerns and insufficient recognition regarding COVID-19 vaccination remain as obstacles for breast cancer patients. Future interventions regarding these factors and improving publicity and patient education regarding the COVID-19 vaccine might prove helpful.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

XYW, QL, WXZ, KXY, YF, and JW were involved in the conception, design, or planning of the study. TW and NCW were involved in the analysis of the data. XYW, QL, WXZ, TW, NCW, ZZW were involved in the acquisition of the data. XYW, QL, WXZ, XYK, YF and JW were involved in the in-

terpretation of the results. XYW, QL, WXZ, XYK, YF and JW were involved in drafting the manuscript. All authors reviewed or revised the manuscript for important intellectual content, approved the final version of the manuscript, and are accountable for the work.

Data Availability

The authors declare that all supporting data are included in the manuscript. Additional data are available upon reasonable request to corresponding author.

Abbreviations

COVID-19: coronavirus disease 2019; SARS-CoV-2: severe acute respiratory syndrome coronavirus 2; WHO: World Health Organization; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

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