

# 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 COV-ID-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:

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0.15; 95% CI: 0.06 - 0.35; P < 0.0001), was associated with COV-ID-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 COV-ID-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 COV-ID-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 We-Chat ID being submit 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 < 5,0000), 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, oneway 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  $49.05 \pm 8.84$  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, endocriotherapy, 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 COV-ID-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)	$48.78\pm8.74$	$50.00\pm9.12$	0.075
Time after surgery (days)	$910.92 \pm 681.51$	$1,272.64 \pm 883.51$	< 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
$\geq$ 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.

	Statistics	OR (95% CI)	P-value
Age (years)	$49.05\pm8.84$	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	10 (110)/0)	0.17 (0.02 1.17)	0.1122
No	916 (97.03%)	1	
Yes	28 (2.97%)	0.56 (0.19 - 1.63)	0.2885
Personal COVID-19 history	20 (2.7770)	0.00 (0.17 - 1.05)	0.2005
No	930 (98.52%)	1	
110	<i>330 (30.3270)</i>	1	

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

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	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	2 (0.2170)	1111	1111
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	57 (10.2070)	0.07 (0.02 1.17)	0.0100
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	128 (15.5070)	0.20 (0.12 - 0.50)	0.0005
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'	101 (19.1770)	0.05 (0.51 - 1.55)	0.2372
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

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

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

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Indefinite suggestion       Ref         No communication with doctors $0.68 (0.45 - 1.03)$ Recommended $5.58 (3.70 - 8.41)$ Not recommended $0.26 (0.12 - 0.56)$ Vactination suggestion from around people $0.26 (0.12 - 0.56)$ Vactination suggestion from around people $0.56 (0.31 - 1.33)$ Not recommended $0.56 (0.31 - 1.33)$ Not recommended $0.65 (0.31 - 1.33)$ Not recommended $0.65 (0.31 - 1.33)$ Not recommended $0.55 (0.31 - 0.28)$ No $0.70 (0.12 - 0.26)$ No $0.55 (0.51 - 0.28)$ No $0.55 (0.51 - 0.28)$ No $0.55 (0.56 - 0.28)$ No $0.50 (0.12 - 0.26)$ No $0.50 (0.12 - 0.26)$ No $0.50 (0.12 - 0.28)$	Vaccination suggestion from surgeon or	or oncologist				
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Recommended       5.58 (3.70 - 8.41)         Not recommended       0.26 (0.12 - 0.56)         Vaccination suggestion from around people       Ref         No suggestion       Ref         Not recommended       0.55 (0.12 - 0.56)         Not recommended       0.55 (0.11 - 1.33)         Not recommended       0.55 (0.31 - 1.33)         Not recommended       0.55 (0.16 - 0.39)         No       vaccination by the residents' committee or employer         Ref       No       0.55 (0.16 - 0.39)         No       No       0.25 (0.16 - 0.39)         No       0.55 (0.16 - 0.39)       0.25 (0.16 - 0.39)         No       No       0.25 (0.16 - 0.30)         No       No       0.25 (0.16 - 0.39)         No       No       0.25 (0.16 - 0.30)         No       No       0.25 (0.16 - 0.39)         No <td>No communication with doctors</td> <td></td> <td>0.68 (0.45 - 1.03), 0.0706</td> <td>0.68 (0.45 - 1.04), 0.0757</td> <td>0.80 (0.52 - 1.24), 0.3149</td> <td>149</td>	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	149
Not recommended       0.26 (0.12 - 0.56)         Vaccination suggestion from around people       0.26 (0.12 - 0.56)         Vaccination suggestion       Ref         No suggestion       11.54 (7.70 - 17.3)         Not recommended       0.65 (0.31 - 1.33)         Not recommended       0.65 (0.31 - 1.33)         Not recommended       0.55 (0.31 - 1.33)         Calls for vaccination by the residents' committee or employer       Ref         Yes       0.25 (0.16 - 0.39)         No       vaccinal notice       0.25 (0.16 - 0.39)         No       vaccinal notice       0.25 (0.16 - 0.39)         No       vaccinal notice       0.12 (0.05 - 0.28)         No       vaccination suggestion from       No         Vaccination suggestion from       No         Vaccination suggestion </td <td>Recommended</td> <td></td> <td>5.58 (<math>3.70 - 8.41</math>), <math>&lt; 0.0001</math></td> <td>5.44 (3.57 - 8.27), &lt; 0.0001</td> <td>5.52 (3.50 - 8.71), &lt; 0.0001</td> <td>.0001</td>	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	.0001
Vaccination suggestion from around people       No suggestion       Ref         No suggestion       11.54 (7.70 - 17.3)         Not recommended       0.65 (0.31 - 1.33)         Calls for vaccination by the residents' committee or employer       Ref         Yes       Ref         No vaccinal notice       0.25 (0.16 - 0.39)         No       0.12 (0.05 - 0.28)         No       0.12 (0.05 - 0.28)         Non-adjusted for none. Minimally adjusted model: we adjusted for age:       0.12 (0.05 - 0.28)         Non-adjusted for none. Minimally adjusted model: we adjusted for age:       0.12 (0.05 - 0.28)         Non-adjusted for age: time after surgery: surgical method: axillary lymph node dissection; breas       0.12 (0.05 - 0.28)         Non-adjusted for age: time after surgery surgical method: axillary lymph node dissection; breas       0.12 (0.05 - 0.28)         Non-adjusted for age: time after surgery surgical method: axillary lymph node dissection; breas       0.12 (0.05 - 0.28)         Non-adjusted for age: time after surgery and method: axillary lymph node dissection; breas       0.25 (0.16 - 0.39)         Non-adjusted for age: time after surgery and posted for age: time after surgery and	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	107
No suggestionRefRecommended11.54 (7.70 - 17.3)Not recommended0.65 (0.31 - 1.33)Not recommended0.65 (0.31 - 1.33)Calls for vaccination by the residents' committee or employerRefYesRef0.25 (0.16 - 0.39)Novaccinal notice0.25 (0.16 - 0.39)Novaccinal notice0.12 (0.05 - 0.28)Novaccinal notice0.12 (0.05 - 0.28)Novaccinal motice0.12 (0.05 - 0.28)Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age;0.12 (0.05 - 0.28)Non-adjusted for: none. Minimally adjusted model: we adjusted for age;0.12 (0.05 - 0.28)Non-adjusted for: none. Minimally adjusted model: we adjusted for age;0.12 (0.05 - 0.28)Non-adjusted for: none. Minimally adjusted model: we adjusted for age;0.12 (0.05 - 0.28)Non-adjusted for: none. Minimally adjusted model: we adjusted for age;0.12 (0.05 - 0.28)Non-adjusted for: none. Minimally adjusted model: we adjusted for age;0.12 (0.05 - 0.28)No communication with doctors1571No communication with doctors1420.76 (0.38 - 1.5)No communication with doctors1420.76 (0.38 - 1.5)No communication with doctors1420.76 (0.38 - 1.5)No communication with doctors1420.76 (0.39 (0.13 - 1.1)Indefinite suggestion1791No communication with doctors1461No communication with doctors1420.76 (0.39 (0.13 - 1.1)Mo communication with doctors <td>Vaccination suggestion from around pe</td> <td>eople</td> <td></td> <td></td> <td></td> <td></td>	Vaccination suggestion from around pe	eople				
Recommended       11.54 (7.70 - 17.3)         Not recommended       0.65 (0.31 - 1.33)         Calls for vaccination by the residents' committee or employer       0.65 (0.31 - 1.33)         Yes       Ref         Yo       0.25 (0.16 - 0.39)         No vaccinal notice       0.25 (0.16 - 0.39)         No       0.12 (0.05 - 0.28)         Yaciables       Effect Size of External Supports on COVID-19 Vaccination in Prespection is the surgent recurrence of hereast cancer before vaccination in Prespective         Yaciables       No.         Vaccination suggestion from suggestion from suggestion from suggestion from suggestion in Prespective         Yaciables       Age elow         Indefinite suggestion       157         No communication with doctors<	No suggestion		Ref	Ref	Ref	
Not recommended       0.65 (0.31 - 1.33)         Calls for vaccination by the residents' committee or employer       Ref         Yes       Ref         No       0.25 (0.16 - 0.39)         No       0.12 (0.05 - 0.28)         Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age: justed for age; time after surgical method; axillary tymph node dissection; breas neoadjuvant therapy; undergoing treatment; recurrence of herast cancer before vaccinative yearly personal income; marital status; region of living in China; place of residence. OR: of treated or age; time after surgestion from suggestion	Recommended		11.54 (7.70 - 17.28), < 0.0001	11.37 (7.58 - 17.06), < 0.0001	1 11.65 (7.57 - 17.91), < 0.0001	0.0001
Calls for vaccination by the residents' committee or employer       Ref         Yes       Ref         No       0.12 (0.05 - 0.39)         No       0.12 (0.05 - 0.39)         No       0.12 (0.05 - 0.28)         Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age;         justed for age; time after surgery; surgical method; axillary lymph node dissection; brass         posodjuvant therapy; undergoing treatment; recurrence of breast cancer before vaccinati         yearly personal income; marital status; region of living in China; place of residence. OR:         typele 4. Effect Size of External Supports on COVID-19 Vaccination in Prespective         Variables       No.         Vaccination suggestion from       No.         surgeon or oncologist       Age = low         Indefinite suggestion       157         No communication with doctors       142         Not recommended       68         Not recommended       10.39 (0.13 - 1.1         No communication with doctors       142         No communication with doctors       142         No commended       68         No communication with doctors <td< td=""><td>Not recommended</td><td></td><td>0.65 (0.31 - 1.33), 0.2372</td><td>0.64 (0.31 - 1.32), 0.2262</td><td>0.66 (0.31 - 1.42), 0.2885</td><td>385</td></td<>	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	385
YesRefNo0.25 (0.16 - 0.39)No0.12 (0.05 - 0.28)No0.12 (0.05 - 0.28)Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age;Justed for age; time after surgery; surgical method; axillary lymph node dissection: brassnon-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age;Justed for age; time after surgery; surgical method; axillary lymph node dissection: brassnoadjuvant therapy; undergoing treatment; recurrence of breast cancer before vaccinatiyearly personal income; marital status; region of living in China; place of residence. OR:Table 4. Effect Size of External Supports on COVID-19 Vaccination in PrespectorVariablesNo.VariablesNo.OR (95% CI),Vaccination suggestion fromsurgeon or oncologistAge dichotomousAge dichotomousIndefinite suggestionNo communication with doctorsNo communication with doctorsNo communication with doctorsAdeNo communication with doctorsAdeAdeAdeAdeAdeAdeAdeAdeAdeAdeAdeAdeAdeAde </td <td>Calls for vaccination by the residents' c</td> <td>committee or employer</td> <td></td> <td></td> <td></td> <td></td>	Calls for vaccination by the residents' c	committee or employer				
No vaccinal notice $0.25 (0.16 - 0.39)$ NoNo $0.12 (0.05 - 0.28)$ Non-adjusted model adjusted for age: justed for age; time after surgery; surgical method; axillary lymph node dissection; brass neoadjuvant therapy; undergoing treatment; recurrence of breast cancer before vaccinati yearty personal income; marital status; region of living in China; place of residence. OR:Non-adjusted for age; time after surgery; surgical method; axillary lymph node dissection; brass neoadjuvant therapy; undergoing treatment; recurrence of breast cancer before vaccinati yearty personal income; marital status; region of living in China; place of residence. OR: <b>Table 4.</b> Effect Size of External Supports on COVID-19 Vaccination in Prespec <b>VariablesOR</b> (95% CI),VariablesNo. <b>ON</b> (0.38 - 1.5)VariablesAge alow0.76 (0.38 - 1.5)Age dichotomous1571No communication with doctors685.35 (2.58 - 11.1)Not recommended680.39 (0.13 - 1.1)Mot recommended680.39 (0.13 - 1.1)Mot recommended680.39 (0.13 - 1.1)Mot recommended1791.20 (0.61 - 2.7)No communication with doctors1461.20 (0.61 - 2.7)	Yes		Ref	Ref	Ref	
No       0.12 (0.05 - 0.28)         Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age; justed for age; surges of residence. OR:         Notable       No.         Variable       No.         Variable       No.         Variable       No.         Variable       No.         No communication with doctors       157         Indefinite suggestion       157         Not recommended       68         Si35 (2.58 - 11.         Not recommended       68         Not recommended       68         Not recommended       157         No communication with doctors       120,013 - 1.1         No communication with doctors       142         No communication with doctors       142         No commended       68         No communication with doctors       146	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	.0001
Non-adjusted model adjusted for: none. Minimally adjusted model: we adjusted for age: justed for age; time after surgery; surgical method; axillary lymph node dissection; breas reacaring therapy; undergoing treatment; recurrence of breast cancer before vaccinati yearly personal income; marital status; region of living in China; place of residence. OR: verticable 4. Effect Size of External Supports on COVID-19 Vaccination in Prespector.         Table 4. Effect Size of External Supports on COVID-19 Vaccination in Prespector.       OR (95% CI), OR	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	.0001
No.stion fromstion fromstion fromgistgistage setionsection with doctorscation with doctorsfileandedfilesection with doctorsfilefilefilesection with doctorsfilefilefilefilefilesection with doctorsfile <th>on-adjusted model adjusted for: none. I sted for age; time after surgery; surgica soadjuvant therapy; undergoing treatme sarly personal income; marital status; re <b>able 4.</b> Effect Size of External Sup</th> <th>Minimally adjusted model: we all method; axillary lymph node ent; recurrence of breast cance egion of living in China; place o pports on COVID-19 Vaccini</th> <th>model: we adjusted for age; yearly personal income; educational ymph node dissection; breast reconstruction surgery; anti-HER2 i reast cancer before vaccination; personal COVID-19 history; educ ina; place of residence. OR: odds ratio; CI: confidence interval; Re 19 Vaccination in Prespecified and Exploratory Subgroups</th> <th>model: we adjusted for age; yearly personal income; educational level; employment status. Fully adjusted model: we ad- ymph node dissection; breast reconstruction surgery; anti-HER2 therapy; chemotherapy; endocrinotherapy; radiotherapy; reast cancer before vaccination; personal COVID-19 history; educational level; employment; influenza vaccination history; ina; place of residence. OR: odds ratio; CI: confidence interval; Ref: reference. 19 Vaccination in Prespecified and Exploratory Subgroups</th> <th>ment status. Fully adjusted m otherapy; endocrinotherapy; n employment; influenza vaccins</th> <th>odel: we ad- adiotherapy; tion history;</th>	on-adjusted model adjusted for: none. I sted for age; time after surgery; surgica soadjuvant therapy; undergoing treatme sarly personal income; marital status; re <b>able 4.</b> Effect Size of External Sup	Minimally adjusted model: we all method; axillary lymph node ent; recurrence of breast cance egion of living in China; place o pports on COVID-19 Vaccini	model: we adjusted for age; yearly personal income; educational ymph node dissection; breast reconstruction surgery; anti-HER2 i reast cancer before vaccination; personal COVID-19 history; educ ina; place of residence. OR: odds ratio; CI: confidence interval; Re 19 Vaccination in Prespecified and Exploratory Subgroups	model: we adjusted for age; yearly personal income; educational level; employment status. Fully adjusted model: we ad- ymph node dissection; breast reconstruction surgery; anti-HER2 therapy; chemotherapy; endocrinotherapy; radiotherapy; reast cancer before vaccination; personal COVID-19 history; educational level; employment; influenza vaccination history; ina; place of residence. OR: odds ratio; CI: confidence interval; Ref: reference. 19 Vaccination in Prespecified and Exploratory Subgroups	ment status. Fully adjusted m otherapy; endocrinotherapy; n employment; influenza vaccins	odel: we ad- adiotherapy; tion history;
No.       stion from       stion from       gist       Age = low       sgestion       157       cation with doctors       142       cation with doctors       68       anded       68       and after surgery = short       sgestion       179						D fou in
stion from gist Age = low ggestion [57 cation with doctors] 142 ed 68 anded 68 mded 68 Time after surgery = short ggestion with doctors] 146	Variables	No.	OR (95% CI), P-value	No. OR	OR (95% CI), P-value	r 10r 111- teraction
Age = lowsgestion157cation with doctors142cation with doctors68ended68ended68file after surgery = shortsgestion179cation with doctors146	Vaccination suggestion from urgeon or oncologist					
<ul> <li>157</li> <li>142</li> <li>68</li> <li>68</li> <li>68</li> <li>Time after surgery = short</li> <li>179</li> <li>146</li> </ul>	Age dichotomous	Age = low		Age = high		0.922
<ul> <li>142</li> <li>68</li> <li>68</li> <li>68</li> <li>79</li> <li>179</li> <li>146</li> </ul>	Indefinite suggestion	157	1	243 1		
68 68 Time after surgery = short 179 146	No communication with doctors	142	0.76 (0.38 - 1.51), 0.4299	129 0.8	0.86 (0.48 - 1.57), 0.6324	
68 Time after surgery = short 179 146	Recommended	68	5.35 (2.58 - 11.10), < 0.0001	77 6.2	6.20(3.31 - 11.62), < 0.0001	
Time after surgery = short 179 146	Not recommended	68	$0.39\ (0.13\ -1.14),\ 0.0859$	60 0.2	0.26 (0.07 - 0.91), 0.0350	
179 ith doctors 146		Time after $surgery = short$		Time after surgery = long		0.201
146	Indefinite suggestion	179	1	218 1		
	No communication with doctors	146	1.29 (0.61 - 2.73), 0.5077	124 0.6	0.63 (0.35 - 1.14), 0.1289	

0.762

Axillary lymph node dissection = no

Axillary lymph node dissection = yes

85 58

**4.56** (2.46 - 8.46), < 0.0001 0.21 (0.06 - 0.76), 0.0178

12.36 (5.35 - 28.57), < 0.0001 87 0.67 (0.22 - 2.04), 0.4749 43

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VariablesNoOR (95% CI), PravidueNoIndefinite suggestion2001101Indefinite suggestion2000.900.45 + 1.78, 0.7412125Recommended60.900.45 + 1.78, 0.7412125Recommended60.900.44 (1.17 - 1.68), 0.28676Not recommended00.410.110.41Indefinite suggestion2460.410.410.41No communication with doctors180.410.410.41No communication with doctors180.410.410.41No trecommended00.410.410.410.41No trecommended00.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.250.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41Indefinite suggestion2160.410.410.410.41 <t< th=""><th></th><th></th><th></th><th></th><th></th><th></th></t<>						
ggestion         209         1           exion with doctors         146         0.89 (0.45 - 1.78), 0.7412           ed         63         5.84 (2.81 - 12.14), <0.0001           ended         66         0.54 (0.17 - 1.68), 0.2867           erion with doctors         188         0.67 (0.17 - 1.68), 0.2867           gestion         246         1         0.63 (0.37 - 1.2.14), <0.0001           ended         9         0.69 (0.37 - 1.2.7), 0.2288         0.69 (0.37 - 1.2.7), 0.2288           ed         94         0.69 (0.37 - 1.2.0), 0.0927         0.69 (0.37 - 1.2.0), 0.0927           erion with doctors         188         0.69 (0.37 - 1.2.0), 0.0927           erion with doctors         188         0.69 (0.37 - 1.2.0), 0.0927           erion with doctors         10         0.69 (0.37 - 1.2.0), 0.0927           erion with doctors         10         0.72 (0.41 - 1.29), 0.2570           erion with doctors         10         0.72 (0.41 - 1.29), 0.0234           erion with doctors         12         0.28 (0.01 - 0.023), 0.0001           erion with doctors         12         0.28 (0.01 - 0.23), 0.0001           erion with doctors         13.5 (0.01 - 0.23), 0.0001         0.26 (0.14 - 1.29), 0.023           erion with doctors         12         13.5 (0.30 - 30.57	Variables	No.	OR (95% CI), P-value	No.	OR (95% CI), P-value	P for in- teraction
action with doctors         146         0.89 (0.45 - 1.78), 0.7412           add         63         54 (0.17 - 1.68), 0.2867           anded         6         0.54 (0.17 - 1.68), 0.2867           anded         6         0.54 (0.17 - 1.68), 0.2867           attend         1         0.54 (0.17 - 1.68), 0.2867           attend         1         0.54 (0.17 - 1.68), 0.2867           attend         246         1           attend         188         0.69 (0.37 - 1.27), 0.2288           attend         188         0.69 (0.37 - 1.27), 0.2288           attend         95         0.41 (0.15 - 1.16), 0.0927           attend         1         0.69 (0.37 - 1.27), 0.2288           attend         66         0.31 (0.15 - 1.16), 0.0927           attend         1         0.41 (0.15 - 1.16), 0.0927           attend         1         0.72 (0.41 - 1.29), 0.2756           attend         1         1           attend         1         1           attend         1         1 <t< td=""><td>Indefinite suggestion</td><td>209</td><td>1</td><td>191</td><td>1</td><td></td></t<>	Indefinite suggestion	209	1	191	1	
d         63         5.84 (2.81 - 12.14), <0.0001           mded         66         0.54 (0.17 - 1.68), 0.2867           remotherapy = yes         Chemotherapy = yes           gestion         246         1           ention with doctors         188         0.69 (0.37 - 1.27), 0.2288           ed         94         0.69 (0.37 - 1.27), 0.2288           adion with doctors         188         0.69 (0.37 - 1.27), 0.2288           gestion with doctors         18         0.69 (0.37 - 1.27), 0.2288           gestion with doctors         18         0.61 (0.15 - 1.16), 0.0927           gestion with doctors         10         0.41 (0.15 - 1.16), 0.0927           gestion with doctors         10         0.72 (0.41 - 1.29), 0.2756           advectors         10         0.72 (0.41 - 1.29), 0.2756           advectors         10         0.28 (0.09 - 0.84), 0.0234           eto         10         0.28 (0.01 - 0.023)           advectors         10         0.28 (0.01 - 0.023)           advectors         10         12.58 (6.56 - 24.88), <0.0001	No communication with doctors	146	0.89 (0.45 - 1.78), 0.7412	125	0.74 ( $0.41 - 1.33$ ), $0.3151$	
mded         66         0.54 (0.17 - 1.68), 0.2867           remontempy = yes         chemotherapy = yes           gestion         246         1           cation with doctors         188         0.69 (0.37 - 1.27), 0.2288           cation with doctors         188         0.69 (0.37 - 1.27), 0.2288           action with doctors         10         0.61 (0.15 - 1.16), 0.0927           mded         95         0.41 (0.15 - 1.16), 0.0927           moded         55,0000         0.41 (0.15 - 1.16), 0.0927           moded         10         0.41 (0.15 - 1.16), 0.0927           moded         10         0.41 (0.15 - 1.16), 0.0927           moded         10         0.41 (0.15 - 1.16), 0.0927           gestion         10         0.41 (0.15 - 1.16), 0.0927           moded         10         0.41 (0.15 - 1.16), 0.0927           demostry         10         0.41 (0.15 - 1.16), 0.0927           ation with doctors         10         0.28 (0.09 - 0.849), 0.0001           moded         10         0.28 (0.32 - 2.55), 0.8409           moded         10         10           moded         11         10           moded         12         11           moded         11         12	Recommended	63	5.84(2.81 - 12.14), < 0.0001	82	5.89(3.17 - 10.95), < 0.0001	
Chemotherapy = yes         Chemotherapy = yes           gestion         246         1           eation with doctors         188         0.69 (0.37 - 1.27), 0.2288           ad         94         0.69 (0.37 - 1.27), 0.2288           anded         95         0.41 (0.15 - 1.16), 0.0927           anded         95         0.41 (0.15 - 1.16), 0.0927           gestion         216         0.41 (0.15 - 1.16), 0.0927           gestion         216         0.41 (0.15 - 1.16), 0.0927           gestion         216         0.41 (0.15 - 1.16), 0.0927           ation with doctors         10         0.72 (0.41 - 1.29), 0.2750           add         100         0.28 (0.09 - 0.84), 0.0234           ation         100         0.28 (0.09 - 0.84), 0.0234           ation         100         0.28 (0.32 - 2.55), 0.8409           ation         100         0.28 (0.32 - 2.55), 0.8409           ation         126         0.28 (0.32 - 2.55), 0.8409           ation         205         127 (0.41 - 1.29), 0.2001           add         12         128 (6.36 - 2.488), <0.0001	Not recommended	66	0.54 (0.17 - 1.68), 0.2867	62	0.23 (0.07 - 0.71), 0.0104	
ggestion         246         1           eation with doctors         188         0.69 (0.37 - 1.27), 0.2288           ed         9         0.69 (0.37 - 1.27), 0.2288           anded         9         0.61 (0.15 - 1.16), 0.0027           anded         9         0.41 (0.15 - 1.16), 0.0027           anded         216         0.41 (0.15 - 1.16), 0.0027           gestion         12         0.41 (0.15 - 1.16), 0.0027           anded         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         100         0.28 (0.09 - 0.84), 0.0234           ation with doctors         126         0.72 (0.41 - 1.29), 0.2760           ation with doctors         126         0.72 (0.41 - 1.29), 0.2760           ation with doctors         126         0.72 (0.41 - 1.29), 0.2760           ation with doctors         126         0.72 (0.41 - 1.29), 0.2760           ation with doctors         205         0.26 (0.14 - 2.21), 0.4052           ation with doctors         217         1           ation w		Chemotherapy = yes		Chemotherapy = no		0.331
action with doctors1880.69 (0.37 - 1.27), 0.2288ad946.79 (3.62 - 12.74), <0.0001	Indefinite suggestion	246	1	154	1	
df         94         6.79 (3.62 - 12.74), < 0.0001           nded         95         0.41 (0.15 - 1.16), 0.0927           nded         7         Yertly personal           gestion         216         0.41 (0.15 - 1.16), 0.0927           gestion         10         0.41 (0.15 - 1.16), 0.0927           gestion         216         0.72 (0.41 - 1.29), 0.2750           ation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         160         0.28 (0.09 - 0.84), 0.0234           nded         66         0.28 (0.09 - 0.84), 0.0234           ation         100         0.205           nded         66         0.206 (0.32 - 2.55), 0.8409           nded         11         12.58 (6.36 - 24.88), < 0.0001	No communication with doctors	188	0.69 (0.37 - 1.27), 0.2288	83	0.81 (0.41 - 1.60), 0.5405	
anded         95         0.41 (0.15 - 1.16), 0.0927           Karly personal         Yearly personal         Yearly personal           gestion         216         1           gestion         152         0.72 (0.41 - 1.29), 0.2750           eation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation with doctors         152         0.72 (0.41 - 1.29), 0.2750           ation         100         5.68 (3.21 - 10.05), < 0.0001	Recommended	94	6.79 (3.62 - 12.74), < 0.0001	51	3.19 (1.51 - 6.73), 0.0024	
Yearly personal           gestion         216         1           action with doctors         15         0.72 (0.41 - 1.29), 0.2750           action with doctors         152         0.72 (0.41 - 1.29), 0.2750           action with doctors         153         0.72 (0.41 - 1.29), 0.2750           action with doctors         100         5.68 (0.09 - 0.84), 0.0234           action         66         0.28 (0.09 - 0.84), 0.0234           action         Age = low         1           n         205         1           action         206 (0.12 - 2.55), 0.8409           n         205 (0.14 - 2.21), 0.4052           action         1         1           n         205 (0.14 - 2.21), 0.4052           action         1         1           action         1         1           action         1         1         1           action         3         3         3           action         3	Not recommended	95	0.41 (0.15 - 1.16), 0.0927	33	0.23 (0.06 - 0.88), 0.0320	
gestion         216         1           cation with doctors         152         0.72 (0.41 - 1.29), 0.2750           cation with doctors         100         5.68 (3.21 - 10.05), < 0.0001		Yearly personal income $\geq 50,000$		Yearly personal income < 50,000		0.927
action with doctors1520.72 (0.41 - 1.29), 0.2750ad1005.68 (3.21 - 10.05), < 0.0001	Indefinite suggestion	216	1	184	1	
d1005.68 (3.21 - 10.05), < 0.0001ended60.28 (0.09 - 0.84), 0.0234stion60.28 (0.09 - 0.84), 0.0234stionAge = low1n2051ad10112.58 (6.36 - 24.88), < 0.0001n2051ad14112.58 (6.36 - 24.88), < 0.0001ad14112.58 (6.36 - 24.88), < 0.0001ad14112.58 (6.36 - 24.88), < 0.0001aded14112.58 (6.36 - 24.88), < 0.0001aded14112.58 (6.36 - 24.88), < 0.0001aded14112.58 (6.36 - 24.88), < 0.0001anded14112.58 (6.36 - 24.88), < 0.0001anded13.90 (6.30 - 30.67), < 0.0001aded10213.90 (6.30 - 30.67), < 0.0001anded10213.90 (6.30 - 30.67), < 0.0001anded10710.40 (0.11 - 1.44), 0.1607anded1070.40 (0.11 - 1.44), 0.1607anded19112.16 (6.72 - 22.02), < 0.0001	No communication with doctors	152	0.72 (0.41 - 1.29), 0.2750	119	0.88 (0.43 - 1.80), 0.7174	
nded         66         0.28 (0.09 - 0.84), 0.0234           stion         fill         1           stion         Age = low         Age = low           n         Age = low         1           add         141         12.58 (6.36 - 24.88), < 0.0001	Recommended	100	5.68 (3.21 - 10.05), < 0.0001	45	5.66(2.44 - 13.14), < 0.0001	
stion le March Age = low 1205 1 141 205 36 - 24.88), < 0.0001 add 141 12.58 (6.36 - 24.88), < 0.0001 mded 207 0.90 (0.32 - 2.55), 0.8409 171 me after surgery = short 170 13.90 (6.30 - 30.67), <0.0001 13.90 (6.30 - 30.67), <0.0001 13.90 (6.30 - 30.67), <0.0001 13.90 (6.30 - 30.67), <0.0001 102 217 13.90 (6.30 - 30.67), <0.0001 mded 129 235 13.90 (6.30 - 30.67), <0.0001 mded 235 13.90 (6.30 - 30.67), <0.0001 mded 149 107 235 13.90 (6.30 - 30.67), <0.0001 mded 149 107 235 13.90 (6.30 - 30.67), <0.0001 mded 191 12.16 (6.72 - 22.02), <0.0001	Not recommended	66	0.28 (0.09 - 0.84), 0.0234	62	0.45 (0.13 - 1.48), 0.1868	
Age = lown $205$ ad $141$ $205$ $1$ ad $141$ $205$ $12.58 (6.36 - 24.88), < 0.0001$ anded $89$ anded $89$ $12.58 (6.36 - 24.88), < 0.0001$ anded $12.58 (6.36 - 24.88), < 0.0001$ anded $12.58 (6.36 - 24.88), < 0.0001$ anded $217$ $1100000000000000000000000000000000000$	Vaccination suggestion from around people					
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Age dichotomous	Age = low		Age = high		0.600
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	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	
Time after surgery = short $217$ 1 $217$ 1 $217$ 1 $217$ 1 $149$ 1 $120$ 0.56 (0.14 - 2.21), 0.4052 $4ed$ 0.56 (0.14 - 2.21), 0.4052 $Axillary lymph node0.56 (0.14 - 2.21), 0.4052Axillary lymph node1Axillary lymph node14ed2.3523511428.27 (4.38 - 15.64), <0.0001$	Not recommended	89	0.90 (0.32 - 2.55), 0.8409	92	0.41 (0.12 - 1.46), 0.1687	
$ \begin{array}{llllllllllllllllllllllllllllllllllll$		Time after surgery = short		Time after surgery = long		0.853
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	No suggestion	217	1	216	1	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	Recommended	149	13.90 (6.30 - 30.67), <0.0001	179	11.78 (6.72 - 20.65), < 0.0001	
Axillary lymph node         dissection = yes         235         1         235         142         8.27 (4.38 - 15.64), < 0.0001	Not recommended	102	0.56 (0.14 - 2.21), 0.4052	77	0.68 (0.26 - 1.79), 0.4343	
$\begin{array}{cccc} 235 & 1 \\ 142 & 8.27 (4.38 - 15.64), < 0.0001 \\ 107 & 0.40 (0.11 - 1.44), 0.1607 \\ 0.40 (0.11 - 1.44), 0.1607 \\ 0.40 (0.11 - 1.42), 0.1607 \\ 0.40 (0.11 - 1.42), 0.1607 \\ 107 & 0.1607 \\ 101 & 101 \\ 101$		Axillary lymph node dissection = yes		Axillary lymph node dissection = no		0.241
142 $8.27$ ( $4.38 - 15.64$ ), $< 0.0001$ $107$ $0.40$ ( $0.11 - 1.44$ ), $0.1607$ Chemotherapy = yes $1$ $302$ $1$ $191$ $12.16$ ( $6.72 - 22.02$ ), $< 0.0001$	No suggestion	235	1	199	1	
107     0.40 (0.11 - 1.44), 0.1607       Chemotherapy = yes     302       1     12.16 (6.72 - 22.02), < 0.0001	Recommended	142	8.27 (4.38 - 15.64), < 0.0001	187	17.19 (9.15 - 32.30), < 0.0001	
Chemotherapy = yes 302 1 191 12.16 (6.72 - 22.02), < 0.0001	Not recommended	107	0.40 (0.11 - 1.44), 0.1607	74	0.97 (0.36 - 2.63), 0.9491	
302 1 191 12.16 (6.72 - 22.02), < 0.0001		Chemotherapy $=$ yes		Chemotherapy = $no$		0.907
191 12.16 (6.72 - 22.02), < 0.0001	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	Not recommended	130	0.59 (0.21 - 1.66), 0.3166	51	0.84 (0.25 - 2.84), 0.7794	

Variables	No.	OR (95% CI), P-value	No.	OR (95% CI), P-value	P for in- teraction
	Yearly personal income $\geq 50,000$		Yearly personal income < 50,000		0.736
No suggestion	235	1	199	1	
Recommended	202	13.78 (7.73 - 24.57), < 0.0001	127	10.47 (5.20 - 21.08), < 0.0001	
Not recommended	97	0.79 (0.30 - 2.10), 0.6396	84	0.45 (0.12 - 1.70), 0.2375	
Calls for vaccination by the residents' committee or employer					
Age dichotomous	Age = low		Age = high		0.421
Yes	293	1	298	1	
No vaccinal notice	87	0.37 (0.18 - 0.79), 0.0104	150	0.19 (0.10 - 0.38), < 0.0001	
No	55	0.12 (0.03 - 0.53), 0.0050	61	0.16 (0.05 - 0.46), 0.0008	
	Time after surgery = short		Time after surgery = long		0.283
Yes	282	1	308	1	
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		Axillary lymph node dissection = no		0.331
Yes	274	1	317	1	
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		Chemotherapy = no		0.801
Yes	370	1	221	1	
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 $\geq 50,000$		Yearly personal income < 50,000		0.932
Yes	367	1	224	1	
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	

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

Unvaccinated	Vaccinated	OR (95% CI)	<b>P-value</b>
730	214		
		1.17 (1.01 - 1.33)	< 0.001
592 (81.10%)	98 (45.79%)		
53 (7.26%)	112 (52.34%)		
85 (11.64%)	4 (1.87%)		
		0.73 (0.57 - 0.89)	< 0.001
284 (38.90%)	53 (24.77%)		
189 (25.89%)	108 (50.47%)		
246 (33.70%)	33 (15.42%)		
11 (1.51%)	20 (9.35%)		
		0.40 (0.25 - 0.55)	< 0.001
580 (79.45%)	199 (92.99%)		
150 (20.55%)	15 (7.01%)		
		1.02 (0.86 - 1.18)	< 0.001
572 (78.36%)	74 (34.58%)		
147 (20.14%)	139 (64.95%)		
11 (1.51%)	1 (0.47%)		
		0.74 (0.59 - 0.90)	< 0.001
355 (48.63%)	175 (81.78%)		
375 (51.37%)	39 (18.22%)		
59 53 85 85 85 85 85 28 18 18 11 11 11 11 11 11 11 11 11 11 11	2 (81.10%) (7.26%) (11.64%) 9 (25.89%) 6 (33.70%) (1.51%) 0 (20.55%) 0 (20.55%) 2 (78.36%) 7 (20.14%) (1.51%) 5 (48.63%) 5 (51.37%)	(81.10%) 7.26%) 11.64%) (38.90%) (33.70%) (25.89%) (33.70%) (151%) (20.55%) (20.14%) (151%) (20.14%) (151%) (48.63%) (51.37%)	(81.10%)       98 (45.79%)         7.26%)       112 (52.34%)         11.64%)       4 (1.87%)         (33.90%)       53 (24.77%)         (33.90%)       53 (24.77%)         (33.90%)       53 (24.77%)         (33.70%)       33 (15.42%)         (1.51%)       20 (9.35%)         (1.51%)       20 (9.35%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       199 (92.99%)         (79.45%)       15 (7.01%)         (78.36%)       15 (7.01%)         (78.36%)       175 (81.78%)         (1.51%)       10.47%)         (48.63%)       175 (81.78%)         (51.37%)       39 (18.22%)

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

believed in the need for vaccinations against COVID-19 in China to be strong. We found recognitions regarding the COV-ID-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 COV-ID-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

# References

- 1. Zhang W, Wang X, Fang Y, Wang J. Comments on: margins in breast-conserving surgery after neoadjuvant therapy. Ann Surg Oncol. 2021;28(7):4051-4052.
- Consortium WHOST, Pan H, Peto R, Henao-Restrepo AM, Preziosi MP, Sathiyamoorthy V, Abdool Karim Q, et al. Repurposed antiviral drugs for COVID-19 - Interim WHO solidarity trial results. N Engl J Med. 2021;384(6):497-511.
- Desai A, Gainor JF, Hegde A, Schram AM, Curigliano G, Pal S, Liu SV, et al. COVID-19 vaccine guidance for patients with cancer participating in oncology clinical trials. Nat Rev Clin Oncol. 2021;18(5):313-319.
- 4. Desai A, Gupta R, Advani S, Ouellette L, Kuderer NM, Lyman GH, Li A. Mortality in hospitalized patients with cancer and coronavirus disease 2019: A systematic review and meta-analysis of cohort studies. Cancer. 2021;127(9):1459-1468.
- Passamonti F, Cattaneo C, Arcaini L, Bruna R, Cavo M, Merli F, Angelucci E, et al. Clinical characteristics and risk factors associated with COVID-19 severity in patients with haematological malignancies in Italy: a retrospective, multicentre, cohort study. Lancet Haematol. 2020;7(10):e737e745.
- 6. Wu L, Zhang C, Zhao X. The impact of COVID-19 pandemic on lung cancer community. World J Oncol. 2021;12(1):1-6.
- Hassan H, Elazar A, Takabe K, Datta R, Takahashi H, Seitelman E. Scalp leiomyosarcoma: diagnosis and treatment during a global pandemic with COVID-19. World J Oncol. 2021;12(4):132-136.
- Corti C, Crimini E, Tarantino P, Pravettoni G, Eggermont AMM, Delaloge S, Curigliano G. SARS-CoV-2 vaccines for cancer patients: a call to action. Eur J Cancer. 2021;148:316-327.

- 9. Waissengrin B, Agbarya A, Safadi E, Padova H, Wolf I. Short-term safety of the BNT162b2 mRNA COVID-19 vaccine in patients with cancer treated with immune checkpoint inhibitors. Lancet Oncol. 2021;22(5):581-583.
- Terpos E, Zagouri F, Liontos M, Sklirou AD, Koutsoukos K, Markellos C, Briasoulis A, et al. Low titers of SARS-CoV-2 neutralizing antibodies after first vaccination dose in cancer patients receiving checkpoint inhibitors. J Hematol Oncol. 2021;14(1):86.
- 11. Herishanu Y, Avivi I, Aharon A, Shefer G, Levi S, Bronstein Y, Morales M, et al. Efficacy of the BNT162b2 mRNA COVID-19 vaccine in patients with chronic lymphocytic leukemia. Blood. 2021;137(23):3165-3173.
- Roeker LE, Knorr DA, Thompson MC, Nivar M, Lebowitz S, Peters N, Deonarine I, Jr., et al. COVID-19 vaccine efficacy in patients with chronic lymphocytic leukemia. Leukemia. 2021;35(9):2703-2705.
- Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021;71(3):209-249.
- 14. Villarreal-Garza C, Vaca-Cartagena BF, Becerril-Gaitan A, Ferrigno AS, Mesa-Chavez F, Platas A, Platas A. Attitudes and factors associated with COVID-19 vaccine hesitancy among patients with breast cancer. JAMA Oncol. 2021;7(8):1242-1244.
- 15. Karges B, Schwandt A, Heidtmann B, Kordonouri O, Binder E, Schierloh U, Boettcher C, et al. Association of Insulin Pump Therapy vs Insulin Injection Therapy with severe hypoglycemia, ketoacidosis, and glycemic control among children, adolescents, and young adults with type 1 diabetes. JAMA. 2017;318(14):1358-1366.
- von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP, Initiative S. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Bull World Health Organ. 2007;85(11):867-872.
- 17. VanderWeele TJ. Principles of confounder selection. Eur J Epidemiol. 2019;34(3):211-219.
- Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, Kimball S, et al. A global survey of potential acceptance of a COVID-19 vaccine. Nat Med. 2021;27(2):225-228.
- Brodziak A, Sigorski D, Osmola M, Wilk M, Gawlik-Urban A, Kiszka J, Machulska-Ciuraj K, et al. Attitudes of Patients with Cancer towards Vaccinations-Results of Online Survey with Special Focus on the Vaccination against COVID-19. Vaccines (Basel). 2021;9(5):411.
- 20. Freeman D, Loe BS, Chadwick A, Vaccari C, Waite F, Rosebrock L, Jenner L, et al. COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (Oceans) II. Psychol Med. 2020.
- Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes toward a potential SARS-CoV-2 vaccine : a survey of U.S. Adults. Ann Intern Med. 2020;173(12):964-973.