

# The Current Status of Vaccine Uptake and the Impact of COVID-19 on Intention to Vaccination in Patients with COPD in Beijing

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**Background:** SARS-CoV-2 tends to cause more severe disease in patients with COPD once they are infected. We aimed to investigate the rates of influenza, pneumococcal and COVID-19 vaccination uptake in patients with COPD and to determine whether the COVID-19 pandemic and widespread vaccination against COVID-19 had any impact on the intention to accept influenza vaccines in these patients.

**Methods:** We conducted a multi-center and cross-sectional survey in seven tertiary hospitals in Beijing and consecutively recruited outpatients with COPD from June 1st to July 30th, 2021. The survey included patient's clinical characteristics, uptake of influenza, pneumococcal and COVID-19 vaccination, vaccine knowledge, attitude towards vaccines, and the change of intention to receive influenza vaccination after COVID-19 epidemic and COVID-19 vaccination in Beijing.

**Results:** A total of 264 patients were enrolled. The rate of COVID-19 vaccination during the study period was 39.0%. The rates of influenza vaccination in the past season and pneumococcal vaccination in the past year were 22.7% and 5.7%, respectively. Of the patients who had not received COVID-19 vaccination (n = 161), only 16.2% reported that COVID-19 vaccination was recommended by clinicians, while 23.5% had no knowledge regarding COVID-19 vaccination. About 51.1% of the patients reported that their intention to receive influenza vaccination was influenced by the COVID-19 pandemic. COVID-19 vaccination was independently associated with a positive change in intention to receive influenza vaccination.

**Conclusion:** The coverage rate of COVID-19 vaccination among patients with COPD in Beijing was 39.0%, and that of influenza and pneumococcal vaccination was very low. The COVID-19 pandemic and the COVID-19 vaccination campaign showed a significant, positive impact on patients with COPD in terms of influenza vaccination. Improving awareness of the effectiveness and safety of vaccines among both healthcare professionals and patients could increase vaccination coverage in patients with COPD.

**Keywords:** chronic obstructive pulmonary disease, vaccines, COVID-19, knowledge, attitude

## Introduction

Chronic obstructive pulmonary disease (COPD), characterized by persistent airflow limitation, is the third leading cause of death worldwide,<sup>1</sup> accounting for the highest morbidity and mortality among all the chronic respiratory diseases.<sup>2</sup> COPD is still projected to lead to substantial economic and social burdens.<sup>3</sup> Acute exacerbation of COPD is one of the major events during the natural course of the disease, associated with deterioration of health status, increasing hospitalization and

readmission, and poor prognosis. Therefore, prevention of subsequent exacerbations is a major goal of the disease management.<sup>3</sup>

Exacerbations of COPD are commonly triggered by respiratory virus infections,<sup>4</sup> including influenza,<sup>5</sup> while bacterial infections are other common causes.<sup>6</sup> Vaccination is the most effective measure to prevent influenza infection.<sup>7</sup> Recent studies have demonstrated the protective role of influenza vaccination in COPD patients, with a significant reduction in the risk of exacerbation and influenza-related hospitalization.<sup>8,9</sup> In addition, studies also showed that pneumococcal vaccinations could reduce the likelihood of exacerbation and community-acquired pneumonia among COPD patients.<sup>10</sup> According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, influenza vaccination is recommended for all COPD patients and pneumococcal vaccination is recommended for all patients aged >65 years.<sup>3</sup> However, the coverage of influenza vaccination was still very low among patients with COPD in China, ranging from 0.9% to 3.6%.<sup>11–13</sup> In some developed countries, the coverage of influenza vaccination in COPD populations ranged from 47.9% to 62.7%.<sup>14–17</sup> Similarly, the coverage of pneumococcal vaccination in China was also low, ranging from 0.8% to 30.4%.<sup>12,18,19</sup> A lack of perception of the threat from infections, distrust of the effectiveness of vaccines, fear of side effects, and lack of physician recommendations were the major reasons for individuals against vaccination.<sup>20–23</sup>

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is responsible for the coronavirus disease 2019 (COVID-19) pandemic, tends to cause more severe disease in patients with COPD once they are infected.<sup>24,25</sup> Clinical trials have demonstrated the effectiveness and safety of several types of COVID-19 vaccines in preventing SARS-CoV-2 infection,<sup>26–28</sup> and therefore vaccination for patients with COPD may need to be prioritized for prevention of infection and/or reduction of severe cases. Inactivated COVID-19 vaccines started to be widely used in adult populations in mainland China since the early 2021. During the initial phase of the mass vaccination against COVID-19 in China, those over 60 years old were not covered because of the lack of evidence from clinical trials in this population. Moreover, the coverage rate of COVID-19 vaccination in patients with COPD and their attitude towards COVID-19 vaccination have not been investigated. In addition, whether the COVID-19 epidemic in Beijing in early 2020 and the widespread

vaccination against COVID-19 had any impact on the acceptance of influenza and pneumococcal vaccines was unknown.

To address these questions, we performed an outpatient-based survey of the current status of influenza, pneumococcal and COVID-19 vaccination uptake, as well as the relevant knowledge and the attitude towards vaccination, in patients with COPD from seven tertiary hospitals in Beijing. We hypothesized that COVID-19 and the mass vaccination against COVID-19 would have a positive impact on the intention to receive influenza vaccines in patients with COPD.

## Methods

### Study Design and Subjects

We conducted a multi-center and cross-sectional anonymous survey in the Respiratory Outpatient Clinics in seven tertiary hospitals (Peking University Third Hospital, Beijing Tongren Hospital, Peking University Shougang Hospital, Beijing Chaoyang Hospital, Beijing Jishuitan Hospital, Beijing Hospital, Peking University First Hospital) in Beijing and consecutively recruited patients with COPD from June 1st to July 30th, 2021. All the patients met the diagnosis of COPD according to Global Initiative for Chronic Obstructive Lung Disease (GOLD 2021) guidelines and had definite airflow limitation with a post-bronchodilator forced expiratory volume in 1 second (FEV1)/forced vital capacity (FVC) <0.7.<sup>3</sup> Each patient was recruited once.

Exclusion criteria included: 1) age <40 years; 2) mental diseases; 3) cognitive dysfunction such as vascular dementia or Alzheimer's disease; 3) refusal to participate in this study.

The study protocol was approved by the Independent Ethics Committee of the Peking University Third Hospital (IRB00006761-M2021379) which was the primary research institution of the present study. Written informed consents were obtained from the subjects or their close relatives.

### Questionnaire Design and Data Collection

A standard questionnaire was designed by group discussion with experts from each center. All the clinicians participating in this survey were invited to attend a centralized training session, which was conducted by the primary research institution, Department of

Respiratory and Critical Care Medicine of Peking University Third Hospital. Any identifier to an individual patient, such as identification number and full name, was not collected. The data were analyzed anonymously.

The questionnaire consisted of the following sections:

Demographic information: gender, age, ethnicity, permanent residence, employment status, education level, medical insurances, and smoking status.

Respiratory symptoms, comorbidities and medications for COPD: Respiratory symptoms were assessed by the modified Medical Research Council (mMRC) dyspnea scale.<sup>29</sup> Comorbidities including cardiovascular diseases, diabetes, malignancies, chronic renal or liver diseases and autoimmune diseases were collected. Medications for COPD included inhaled short-acting  $\beta$ -agonist (SABA), inhaled short-acting muscarinic antagonist (SAMA), inhaled corticosteroids plus long-acting  $\beta$ -agonist (ICS/LABA), long-acting muscarinic antagonist (LAMA), LABA/LAMA and LABA/LAMA/ICS (fixed-dose triple therapy).

Vaccination uptake and knowledge of and intention to vaccination: This section included the following items: 1) History of influenza and pneumococcal vaccination; 2) The reason why an individual did not accept seasonal influenza vaccine/pneumococcal vaccine; 3) Knowledge of vaccinations; 4) COVID-19 vaccination; 5) The potential impact of the COVID-19 epidemic and COVID-19 vaccination on the intention to influenza vaccination. The details of the above items are shown in [Figure 1](#).

## Statistical Analysis

Continuous variables were expressed as mean  $\pm$  standard deviation (SD). Categorical variables were expressed as numbers (%). Chi-square test or Fisher's exact test was performed for categorical variables in univariate analysis. Binary logistic regression analysis was performed to assess the independent relation between the change of intention to influenza vaccination after COVID-19 epidemic and COVID-19 vaccination and the relevant factors. In this model, the change of intention to influenza vaccination was the dependent variable and converted to a binary variable, which was recorded as "Yes" or "No". The independent variables associated with the change of intention to influenza vaccination with  $P < 0.1$  in the univariate analysis were also converted to binary variables and then included in multivariate analysis. Statistical analyses were performed using SPSS software, version 19.0 (IBM, Armonk, NY, USA). Results were considered statistically significant at  $P < 0.05$ .

## Results

### Baseline Characteristics of the Study Subjects

We initially recruited 282 patients with definite COPD from June 1st to July 30th, 18 of whom refused to participate in this survey. Finally, a total of 264 (93.6%) patients who completed the questionnaire were enrolled for analysis. The mean age was 68.4 ( $\pm 8.8$ ) years and 89.4% were male. Most of the patients were urban residents (93.6%) and had retired (83.3%). 61.0% of the patients had middle school education and 14.0% had university education or higher. Only 14 patients (5.3%) had no medical insurance, while the others had various kinds of medical insurances or free medical care. Of all the patients, 26.5% were current smokers and 60.6% were ex-smokers, with a smoking index of 35.0 ( $\pm 21.8$ ) pack-years. Four patients (1.5%) ever experienced COVID-19 infection during the epidemic. Cardiovascular diseases (32.6%) and diabetes (15.2%) were the most common comorbidities. More than 80.0% (216/264) received long-term inhaled medications for COPD and 76.1% (201/264) had maintained their medications as prescribed. ICS/LABA (56.0%) and LAMA (48.6%) were the most commonly used pharmacological therapy. The proportions of LABA/LAMA and LABA/LAMA/ICS fixed-dose therapy were 10.2% and 13.4%, respectively ([Table 1](#)).

### The Rates of Influenza, Pneumococcal and COVID-19 Vaccination in Patients with COPD

22.7% of the patients (60/264) received influenza vaccination in the past season (2020/2021), while only 5.7% (15/264) received pneumococcal vaccination in the past year ([Table 2](#)). Among the patients aged  $\geq 60$  years ( $n = 221$ ), the uptake rate of influenza vaccination in the past season was 24.4%. Among the patients aged  $\geq 65$  years ( $n = 189$ ), the uptake rate of pneumococcal vaccination in the past year was 5.8%.

During the study period, 103 (39.0%) patients reported that they had received COVID-19 vaccination ([Table 2](#)).

### Knowledge of and Attitude Towards Influenza and Pneumococcal Vaccinations

Of all the patients, 44.3% (117/264) and 38.6% (102/264) were aware of the benefits of influenza and pneumococcal vaccinations for individuals with COPD, respectively. 151 (57.2%) patients knew that influenza vaccination was free for individuals aged  $\geq 60$  years in Beijing. 112 (42.2%) and

Items	Options
1) History of influenza and pneumococcal vaccination	
Did you receive seasonal influenza vaccines in the past season (2020/2021)?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Did you receive pneumococcal vaccines in the past year?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2) The reason why an individual did not accept seasonal influenza vaccines?	<input type="checkbox"/> worry about the side effects <input type="checkbox"/> do not think the vaccines necessary <input type="checkbox"/> activity inconvenience <input type="checkbox"/> own expense for vaccination <input type="checkbox"/> others _____
The reason why an individual did not accept pneumococcal vaccines?	<input type="checkbox"/> worry about the side effects <input type="checkbox"/> do not think the vaccines necessary <input type="checkbox"/> activity inconvenience <input type="checkbox"/> own expense for vaccination <input type="checkbox"/> others _____
3) Knowledge of vaccinations	
Did you know the benefit of influenza vaccines for individuals with COPD?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Did you know that influenza vaccination was free for individuals aged $\geq 60$ years in Beijing?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Did any medical staffs ever recommend the seasonal influenza vaccines to you?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Did you know the benefit of pneumococcal vaccines for individuals with COPD?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Did any medical staffs ever recommend pneumococcal vaccines to you?	<input type="checkbox"/> Yes <input type="checkbox"/> No
4) COVID-19 vaccination	
Did you receive the COVID-19 vaccine?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Did you ever get any knowledge regarding the COVID-19 vaccines in the hospital or other medical institutions if you had not received the COVID-19 vaccination?	<input type="checkbox"/> Yes, COVID-19 vaccines were recommended by the clinicians <input type="checkbox"/> Yes, but COVID-19 vaccines were not recommended by the clinicians <input type="checkbox"/> Yes, but the clinicians did not give definite recommendation <input type="checkbox"/> No, I did not get any knowledge regarding the COVID-19 vaccines
The reason why an individual did not accept COVID-19 vaccination?	<input type="checkbox"/> worrying about the side effects <input type="checkbox"/> COVID-19 vaccines being not appropriate because of COPD <input type="checkbox"/> activity inconvenience <input type="checkbox"/> others _____
5) Did the COVID-19 epidemic and COVID-19 vaccination have any impact on your intention to influenza vaccination?	<input type="checkbox"/> Yes, I would pay more attention to influenza vaccination <input type="checkbox"/> Yes, I would consider to receive influenza vaccination <input type="checkbox"/> Yes, I have decided to get influenza vaccination this year <input type="checkbox"/> No, my intention to influenza vaccination was not influenced

**Figure I** Vaccination uptake and knowledge of and intention to vaccination in the questionnaire.

**Table 1** Demographic and Clinical Characteristics (n = 264)

Characteristics	Mean±SD or n (%)
Age	68.4±8.8
Gender	
Male	236 (89.4)
Female	28 (10.6)
Residence	
Urban	247 (93.6)
Rural area	17 (6.4)
Education	
Primary school or lower	48 (18.2)
Middle school	161 (61.0)
College	18 (6.8)
University or higher	37 (14.0)
Employment status	
Currently working	24 (9.1)
Retired	220 (83.3)
Other	20 (7.6)
Medical insurance	
No insurance	14 (5.3)
Urban Residents Medical Insurance	196 (74.2)
Free Medical Service	24 (9.1)
Medical Insurance outside Beijing	30 (11.4)
Smoking status	
Current smokers	70 (26.5)
Former smokers	160 (60.6)
Never smokers	34 (12.9)
Smoking index (pack-year) <sup>a</sup>	35.0 ± 21.8
Modified MRC dyspnea scale	
0	32 (12.1)
1	95 (36.0)
2	78 (29.6)
3	46 (17.4)
4	13 (4.9)
Frequency of hospitalization due to COPD exacerbation in 2019 (/year)	0.27 ± 0.62
Frequency of hospitalization due to COPD exacerbation in 2020 (/year)	0.17 ± 0.46
Comorbidities	
Diabetes mellitus	40 (15.2)
Cardiovascular diseases	86 (32.6)
Tumors	18 (6.8)
Chronic liver or renal diseases	5 (1.9)
Autoimmune diseases	3 (1.1)
None of the above	139 (52.7)

(Continued)

**Table 1** (Continued).

Characteristics	Mean±SD or n (%)
Pharmacological treatment	
ICS/LABA	121 (56.0)
LAMA	105 (48.6)
LABA/LAMA	22 (10.2)
LABA/LAMA/ICS (fixed dose triple therapy)	29 (13.4)
SABA or SAMA	13 (6.9)

**Notes:** Data are presented as Mean ± SD or n (%). <sup>a</sup>Smoking index was calculated in current and former smokers.

**Abbreviations:** COPD, chronic obstructive pulmonary disease; MRC, Medical Research Council; ICS, inhaled corticosteroid; LABA, long-acting β-agonist; LAMA, long-acting muscarinic antagonist; SABA, short-acting β-agonist; SAMA, short-acting muscarinic antagonist.

**Table 2** The Rate of Influenza, Pneumococcal and COVID-19 Vaccination (n = 264)

Vaccines	N (%) of Vaccination
Influenza vaccine	60 (22.7)
Pneumococcal vaccine	15 (5.7)
COVID-19 vaccine	103 (39.0%)

**Note:** Data are presented as n (%).

**Abbreviation:** COVID-19, coronavirus disease 2019.

92 (34.9%) of the patients reported that they had ever been recommended for influenza and pneumococcal vaccinations by medical staff, respectively.

In the patients who did not receive influenza vaccination (n = 204), “worrying about the side effects” (61/204, 29.9%) and “do not think it necessary” (54/192, 26.5%) were the most common reasons. Similarly, in the patients who did not receive pneumococcal vaccination (n = 249), the most common reasons were the same (61/249, 24.5%; 60/249, 24.1%, respectively) (Table 3).

Other reasons why an individual did not accept the vaccines were self-reported by the patients. These included having no knowledge of influenza or pneumococcal vaccines, allergic constitution, having other severe diseases, such as malignancies, and not recommended by the general practitioners (Table 3).

## Knowledge of and Attitude Towards COVID-19 Vaccination

Of the patients who did not receive COVID-19 vaccination (n = 161), 31.7% (51/161) had made a decision to get



**Table 3** Reasons for the Patients Who Did Not Receive Influenza or Pneumococcal Vaccination

	Not Receiving Influenza Vaccination (n = 204)	Not Receiving Pneumococcal Vaccination (n = 249)
Worry about the side effects	61 (29.9)	61 (24.5)
Do not think it necessary	54 (26.5)	60 (24.1)
Activity inconvenience	16 (7.8)	13 (5.2)
Own expense for vaccination	4 (2.0)	6 (2.4)
Others	64 (31.4)	106 (42.6)
Having no knowledge of the vaccines	50 (78.1)	87 (82.1)
Having other severe diseases	9 (14.1)	9 (8.5)
Allergic constitution	5 (7.8)	5 (4.7)
Not recommended by the general practitioners	0 (0.0)	5 (4.7)

**Note:** Data are presented as n (%).

COVID-19 vaccination, while the remaining (68.3%, 110/161) did not intend to get COVID-19 vaccination. Only 16.2% (26/161) reported that COVID-19 vaccines were recommended by clinicians, and most of them were not recommended for COVID-19 vaccination (47.8%, 77/161) or did not get definite recommendations from clinicians (12.4%, 20/161). 23.6% (38/161) of them had no knowledge regarding COVID-19 vaccination. In those who did not intend to get COVID-19 vaccination (n = 110), 48.2%

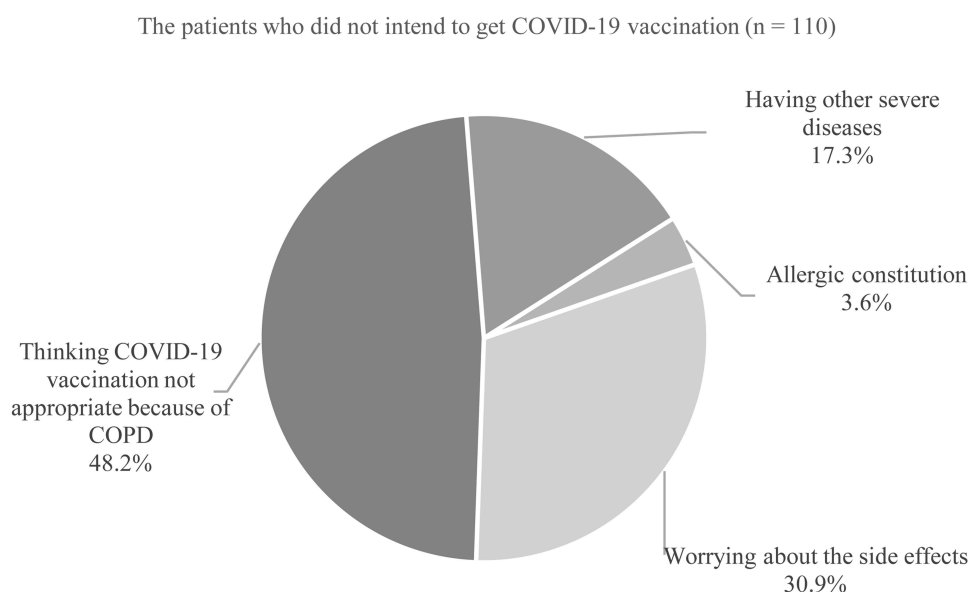
(53/110) thought that COVID-19 vaccines were not appropriate for them because of COPD and 30.9% (34/110) worried about the side effects (Figure 2).

The uptake rate of COVID-19 vaccination in individuals receiving influenza vaccination in the past season was significantly higher than in those not receiving influenza vaccination (61.7% vs 32.4%,  $P < 0.001$ ). Similarly, the individuals receiving pneumococcal vaccination in the past year had a greater rate of COVID-19 vaccination (73.3% vs 36.9%,  $P = 0.005$ ).

### Impact of COVID-19 Pandemic and COVID-19 Vaccination on Intention and Attitude Towards Influenza Vaccination

Of all the patients, over a half (51.1%) reported that their intention to receive influenza vaccination was influenced by the COVID-19 pandemic. 34.5% (91/264) would pay more attention to influenza vaccination, 12.1% (32/264) considered to receive influenza vaccination, and 4.5% (12/264) had decided to get influenza vaccination this year. But, 48.9% (129/264) thought that their attitude to influenza vaccination was not affected by the COVID-19 pandemic.

In patients who had not received influenza vaccination in the past season (n = 204), the rate of COVID-19 vaccine uptake was higher in those reporting that COVID-19 and COVID-19 vaccination did have a positive impact on their intention to receive influenza vaccination, as compared to

**Figure 2** Distribution of the reasons why the patients did not intend to get COVID-19 vaccination (n = 110).

**Table 4** Factors Associated with the Change of Intention to Receive Influenza Vaccination After the COVID-19 Epidemic in Beijing (n = 204)<sup>a</sup>

	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	P-value	OR	95% CI	P-value
Age ≥60 years	0.65	0.32–1.34	0.241			
Education level	N/A	N/A	0.746			
Current-/Ex-smoker	0.89	0.37–2.16	0.797			
≥1 comorbidities	0.79	0.46–1.37	0.407			
Maintaining long-term inhaled medications	1.47	0.79–2.75	0.220			
Knowing the benefit of influenza vaccine	1.53	0.86–2.75	0.151			
Knowing the subsidy policy of influenza vaccination in Beijing	1.78	1.03–3.13	0.039	1.45	0.77–2.71	0.251
Influenza vaccine recommended by medical staffs	1.76	0.98–3.19	0.059	1.42	0.73–2.77	0.299
COVID-19 vaccination	2.39	1.17–3.86	0.013	1.99	1.08–3.65	0.027

**Notes:** <sup>a</sup>Data were analyzed in the patients who did not receive influenza vaccination in the past season (2020/2021, n = 204). Univariate analysis was performed by Chi-square test, while multivariate analysis was performed by binary logistic regression model. The change of intention to influenza vaccination in future was converted to a binary variable, which was recorded as “Yes” or “No”. Except education level, the other variables included in the analysis were also converted to binary variables. The variables with  $P < 0.1$  in the univariate analysis were included in multivariate analysis.

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

those reporting not (40.8% vs 24.5%,  $P = 0.013$ ). Other factors associated with the change of intention to influenza vaccination are presented in Table 4. Knowing the subsidy policy of influenza vaccination in Beijing was statistically associated with the change of intention to influenza vaccination. After adjustment from the variables with  $P < 0.1$  in univariate analysis in Table 4 (ie “Knowing the subsidy policy of influenza vaccination in Beijing” and “influenza vaccination recommended by the medical staffs”), having COVID-19 vaccination remained independently associated with a positive change of intention to influenza vaccination in the logistic regression analysis.

## Discussion

In this cross-sectional survey, we investigated the uptake rate of COVID-19 vaccines during the first vaccination campaign against COVID-19 among patients with COPD in Beijing for the first time. We found that the actual uptake rate of COVID-19 vaccination was relatively low, although most of our patients would like to accept COVID-19 vaccination. To our surprise, nearly one half of the patients who did not receive COVID-19 vaccination had not been recommended for COVID-19 vaccination by their clinicians, which was most likely the main reason that COVID-19 vaccination rate was low among these patients. To our knowledge, there was no evidence regarding the effectiveness and safety of COVID-19 vaccination in patients with COPD, although a recent study demonstrated that the safety and tolerability of mRNA SARS-CoV-2/COVID-19 vaccine was good in severe asthma patients.<sup>30</sup> Another study showed that the

acceptance of COVID-19 vaccination in cancer patients was only 17.8% and a substantial proportion of them thought that COVID-19 vaccination may have negative effect on their cancer treatment.<sup>31</sup> Therefore, doctors may be reluctant to recommend a new vaccine for those with underlying diseases such as COPD and malignancies. The role of medical advice in promoting vaccination campaign has been highlighted in some previous studies.<sup>32–35</sup> Improving the knowledge of medical staff in hospitals and medical institutions regarding the effectiveness, safety and importance of COVID-19 vaccination was an important strategy for increasing vaccination acceptance and coverage. Meanwhile, our data showed that a substantial proportion of our patients did not have the necessary knowledge of and confidence in the effectiveness and safety regarding COVID-19 vaccines, which also served as barriers to improving the coverage of COVID-19 vaccination.

In addition, we found that the uptake rate of COVID-19 vaccination was much higher in patients who had ever received influenza vaccination in the past influenza season or received pneumococcal vaccination in the past year, indicating that the individuals who had been vaccinated with other vaccines might have better adherence and acceptance of COVID-19 vaccines. Previous studies also demonstrated that the individuals receiving influenza vaccination in the 2020–2021 influenza season were more likely to be vaccinated against COVID-19,<sup>36–38</sup> which were similar to our study. We thought that this was reasonable since the attitudes and intentions to other vaccines would affect the acceptance of COVID-19 vaccines.

As expected, we observed that most of our patients did change their attitude towards influenza vaccination after the COVID-19 epidemic in Beijing. Moreover, receiving COVID-19 vaccination was independently and positively associated with the improvement of intention to receive influenza vaccines in patients who did not receive influenza vaccination in the past year. These findings supported our hypothesis that COVID-19 pandemic and widespread acceptance of COVID-19 vaccination would play a positive role in increasing the awareness and acceptance of influenza vaccination in patients with COPD. A previous study also observed that over 90% of the elderly population presented a positive attitude towards pneumococcal vaccine during the COVID-19 pandemic<sup>19</sup> and this proportion was much higher than that reported in Chinese urban elderly population in 2014 (21.77%).<sup>39</sup>

Nevertheless, it needed to be noted that the uptake rates of influenza (22.7%) and pneumococcal (5.7%) vaccines in the past year were very low in our patients, although most of them were aware of the subsidy policy providing free influenza vaccination to Beijing residents aging  $\geq 60$  years, which was implemented since 2007, ahead of most cities in China.<sup>40</sup> Surveys conducted in Beijing found that the overall coverage rate of influenza vaccination was 20.6%, but the rate in those aged  $\geq 60$  years was 38.7%–49.3%,<sup>41,42</sup> which was higher than the rate in our study. Also, the uptake rate of pneumococcal vaccination in our study was even lower, compared to previous studies.<sup>12,43</sup> Concerns about the side effects and the belief that the vaccines were unnecessary or ineffective were common reasons, which were consistent with the previous studies.<sup>21,23</sup> A lack of recommendation from healthcare workers was another reason in our survey, with less than a half of our patients being recommended for influenza or pneumococcal vaccination. Patient education program, media campaign, and the awareness of healthcare workers on the importance of vaccination were required to improve coverage, besides free vaccination policy.

There were several limitations in our study. The first was that the sample size was relatively small, and over 90% of the participants came from urban area. The coverage of vaccination may be different in some rural areas. A study conducted in Shanghai showed that the uptake rate in rural areas was higher for pneumonia vaccination but lower for influenza vaccination than the rate in urban areas.<sup>12</sup> The second was that our patients were from seven tertiary hospitals in Beijing, while primary medical institutions were not included in our

study. Compared with those only managed by primary care providers, patients referred for pulmonary subspecialty evaluation showed significantly higher coverage rates of influenza and pneumococcal vaccination.<sup>44</sup> The third was that this survey study was conducted in Beijing, and therefore the results may not be appropriate to be generalized to other Chinese population. The fourth was that the COVID-19 vaccination program was still ongoing in China and the actual coverage rate of COVID-19 vaccination in 2021 needs to be further updated. Lastly, in our questionnaire, the phrasing “Did you know” might induce a positive answer, which might be prone to acceptability bias.

In conclusion, the uptake rate of COVID-19 vaccination in COPD patients in Beijing was 39.0%, and that of influenza and pneumococcal vaccination was lower. Lack of recommendations from medical staff, and concerns about the effectiveness and side effects of vaccines were the main reasons against vaccination. Importantly, the COVID-19 pandemic and the COVID-19 vaccination campaign showed a significant, positive impact on patients with COPD in terms of influenza vaccination, one of the recommended measures for reducing exacerbation of COPD.

## Data Sharing Statement

The data that supports the findings of this study will not be shared openly with other third parties due to contractual statements related to intellectual property, confidentiality, and proprietary rights.

## Ethics Approval and Informed Consent

The study protocol was approved by the Independent Ethics Committee of the Peking University Third Hospital (IRB00006761-M2021379) which was the primary research institution of the present study. Informed consent was obtained from the patients or their close relatives. This study was conducted in accordance with the Declaration of Helsinki.

## Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval for the



version to be published; and agreed to be accountable for all aspects of the work.

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## Disclosure

The authors report no conflicts of interest in this work.

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