Perception to COVID-19 epidemic and acceptance of vaccination among healthcare workers in Beijing: a survey before the completion of COVID-19 vaccine phase III clinical trials

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Abstract

Background: Covid-19 vaccine research and development is progressing and expected to be put into use in a predictable time, we aimed to learn the awareness and acceptance of the new vaccine by healthcare workers (HCWs) in Beijing, China.

Methods: A cross-sectional survey was conducted to investigate HCWs including doctors, nurses and technicians from sixty hospitals in Beijing to obtain the perception of COVID-19 epidemic and the attitudes towards vaccination before before the completion of vaccine phase III clinical trials. Multivariate analysis was applied to evaluate the associated factors with intention to get vaccination.

Results: A total of 8040 HCWs was recruited. 67.1% reported they would get vaccination, others said unsure or would not. Half of the HCWs were unsure whether the outbreak in China would come back and the global epidemic would last for a long time. 67.6% agreed the epidemic can be prevented by vaccination. Positive associated factors with willingness to get vaccination were mainly included epidemic situation prognosis, perception of disease severity, self infection risk and disease can be prevented by vaccine, etc. Two positive factors of “wanted the vaccine free of charge” (OR:5.807, 95%CI:5.083-6.635, $P<0.001$) and “believed vaccine approved for license have been fully evaluated in clinical trials” (OR:4.485, 95%CI:3.849-5.227, $P<0.001$) were strongly associated with willingness to get vaccination, while two factors of “highest academic degree” (OR:0.840, 95%CI:0.772-0.914, $P<0.001$) and “professional ranks and titles” (OR:0.930, 95%CI:0.865-1.000, $P=0.049$) were negative associated .

Conclusions: A little above moderate willingness to get COVID-19 vaccination was found among HCWs in Beijing before the vaccine being licensed. Free vaccination strategy should be considered to implement, effective measures should be taken to remove barriers and convey correct information through appropriate ways to enhance the acceptance of COVID-19 vaccination among HCWs in China.

Background

The COVID-19 pandemic due to infection by the novel SARS-CoV-2 virus with disease symptoms ranges from asymptomatic infections to mild respiratory symptoms, severe pneumonia, acute respiratory distress, and fatality, has resulted in global public health and economic crises since the end of 2019[1-5]. Despite scientific misgivings such as vaccine safety concerns associated with antibody-dependent disease enhancement (ADE) in previous coronavirus animals-vaccinated studies [6], and some socio-political controversies [7], general consensus is that a successful vaccine should be developed as soon as possible to reduce morbidity and mortality [8]. Academic institutions and commercial companies of different countries have been pushing research and development progress and achieving landmark results over the past months[9-11]. Most of COVID-19 vaccine candidates are based on S antigen either as inactivated vaccines, subunit vaccines, viral vectored vaccines, and nucleic acid-based DNA or mRNA vaccines [6]. Latest news indicated that several candidates has entered phase III clinical trials. If the processes continue to go smoothly, the COVID-19 vaccine will be used in wider range of population in a

predictable time. What's more, continuous pandemic will generate simultaneous demand for vaccination around the world.

Evidence-based data collection work should certainly be continued, based on experiences of pandemic influenza A (H1N1) vaccine guidelines, it is highly likely that the healthcare workers (HCWs) will be recommended as a priority population as soon as the vaccine been licensed or has been approved for legal chartered emergency vaccination. Lessons also told us that even if the vaccine is successfully developed, future vaccination acceptance of different population including HCWs may not reach the ideal state[12]. In countries such as China, where Non-Pharmacological interventions (NPI, including early case identification and isolation, effectively close contact tracing and management, strictly social distancing, improved hygiene and commonly masks wearing and so on) [13] are strictly implemented and the epidemic was effectively controlled, the awareness and acceptance of the new COVID-19 vaccine by HCWs is still not learn. We conducted a cross-sectional survey in Beijing and hoped to provide references for formulating rational vaccination strategy for China and other counties.

Methods

Settings

According to geographical location, in all 16 districts of Beijing, we opted for Chaoyang and Fengtai district located in urban areas, Changping and Daxing district in the suburbs, Miyun and Huairou district in the outer suburbs, a total of 6 districts to participate in the survey. 10 hospitals in each district, including 2 level III general hospitals, 2 level II general hospitals and 6 level I hospitals/community health centers, were randomly selected. During the COVID-19 epidemic in Beijing, Level II and III general hospitals took responsibility for the diagnosis and treatment of cases, and Level I hospitals/community health center were involved in community population screening or nucleic acids sampling. We assumed that HCWs in these hospitals were facing occupational exposure risk.

Two infectious disease hospitals that specialize in treating COVID-19 patients, Beijing Ditan Hospital and Youan Hospital affiliated with Capital Medical University, were designated to participate in the survey. Specialist hospitals, including traditional Chinese medical hospitals, children's hospitals, maternity hospitals, dental hospitals, etc., as well as hospitals closed during the epidemic, were excluded in the survey. The investigation began in early May and ended at the middle of June in 2020.

Study participants

For each hospital being sampled, all doctors, nurses, technicians in the high-risk departments/units, including emergency departments, fever clinics, respiratory system disease departments, intensive care unit, medical imaging departments and laboratory testing departments, were required to be investigated. For other departments, we identified a lowest limit on the number of participants (if the candidate number does not meet the lowest limit, all staff of the department should be investigated). Prior to the survey, we

collected the number of target respondents in each hospital, and implemented quality control measures to ensure the response rate exceeded 95%.

Study instrument

An anonymous questionnaire was developed that assessed the following characteristics of participants: a) demographic characteristics including age, sex, marital status, family situation, job description; b) perception of risk towards COVID-19 epidemic and the severity of the disease; c) attitudes towards COVID-19 vaccination; d) past vaccination history and medical history. Five-point likert-scale were used to assessing the attitude and perception responses, and finally classified into three categories: positive answer, negative answer and uncertain answer.

Pilot survey were carried out before the formal use of the questionnaire to ensure that the statement of each question was clear and understandable. We made a mobile phone questionnaire, and the survey was completed by scanning the QR code through WeChat App, which was widely used in China to promote the convenience and compliance of the survey, and helped to avoid missing items.

Data analysis

We use Mapinfo 9.5 to build the database. Univariate analysis includes frequency and constituent ratio calculation as well as Pearson's Chi-squared test for differences was performed using SPSS 19.0. Multivariate stepwise logistic regression model was applied to evaluate the associated factors with intention to accept COVID-19 vaccination. The odds ratio and 95% confidence interval were calculated. Alpha was set at the 5% level.

Results

General demographic characteristics

A total of 8040 HCWs participated in the survey, of them 3844 (47.8%) were nurses, 2836 (35.3%) were doctors and 1360 (16.9%) were technicians. Of the respondents, most were less than 50 years old (90.4%) and female (80.4%), 70.3% stated they had participated in the prevention and control of COVID-19 epidemic, 34.4% admitted coming from departments may directly involve in the diagnosis and treatment of patients, and 35.1% reported having received other vaccines in the past 3 years. Details are summarized in table 1.

Perception to COVID-19 epidemic

The vast majority (95.8%) of the respondents considered that consequences of suffering from SARS-CoV-2 infection were "serious". 80.1% perceived they might be infected with the virus. 57.5% admitted they were at greater risk of SARS-CoV-2 infection than others, the proportion of doctors, nurses and technicians holding the view decreased successively ($P < 0.001$). Nearly half of the respondents were unsure whether the outbreak in China would come back, and thought the global COVID-19 epidemic

would last for a long time (59.2% of doctors hold this view, significantly higher than nurses and technicians ($P<0.001$)). 67.6% of the respondents agreed that COVID-19 epidemic can be prevented by vaccination, and a slightly lower proportion believed in the safety and effectiveness of the future vaccine. 73.0% of the respondents reported that their life had been seriously disturbed by the epidemic in the past three months, and 43.6% estimated their life and work would still be disturbed in the next six months. Table 2 shows the differences of perception in doctors, nurses and technicians when answered the same question.

Attitudes to COVID-19 vaccine

Compared with the official media's propaganda (80.4%), HCWs investigated believed more in the professional staff' advice (94.1%). 80.0% were convinced of COVID-19 vaccine approved for license have been fully evaluated in clinical trials, and 77.4% wanted the future vaccine free of charge. Most importantly, 67.1% of HCWs surveyed reported that they would get COVID-19 vaccination, 7.9% said they would not, and 25.0% said they were unsure. The proportion of those would advise family members to get vaccination (68.2%) was similar to that of their own willingness to vaccinate, however, the proportion of willingness to take children to get vaccination was significantly decreased to 61.9%. For the respondents would be vaccinated, vaccination campaign organized by hospital (75.3%) was obviously more acceptable than vaccination offered by community clinic (24.7%). In general, even if there were statistical differences in the answers of doctors, nurses and technicians on some questions for attitudes to COVID-19 vaccine, the proportion was very similar (table3).

Univariate analysis

Univariate associations between intention to accept COVID-19 vaccination and the related variables are shown in table 4. gender ($P=0.011$), age ($P<0.001$), occupation categories ($P<0.001$), ward type ($P<0.001$), highest academic degree ($P<0.001$), professional ranks and titles ($P<0.001$), underlying disease ($P<0.001$), participated in the prevention and control of COVID-19 epidemic ($P=0.019$), received other vaccines in the past 3 years ($P<0.001$) and received seasonal influenza vaccine ($P<0.001$) were significantly associated with greater intention to accept vaccination.

Multiple logistic regression model

In multiple logistic regression models, some factors showed positive significantly association with intention to get vaccination (table 5), which included "level II hospital" (OR:1.303, $P=0.001$), "level III" hospital (OR:1.237, $P=0.004$), "Agreed with suffering from SARS-CoV-2 infection is Serious" (OR:1.368, $P=0.031$), "Agreed with China's COVID-19 epidemic will come back" (OR:1.346, $P<0.001$), "Agreed with the global COVID-19 epidemic will last for a long time" (OR:1.208, $P=0.004$), "Agreed with COVID-19 can be prevented by vaccination" (OR:1.747, $P<0.001$), "Agreed with the COVID-19 vaccine is safe" (OR:1.915, $P<0.001$), "Agreed with the COVID-19 vaccine is effective" (OR:1.409, $P<0.001$), and "Trusted the propaganda of the official media" (OR:1.268, $P=0.002$). Two factors showed stronger positive significantly association, which were "Wanted the COVID-19 vaccine free of charge" (OR:5.807, $P<0.001$)

and “believed COVID-19 vaccine approved for license have been fully evaluated in clinical trials” (OR:4.485, $P<0.001$). Two other factors showed negative significantly association, which were “highest academic degree” (OR:0.840, $P<0.001$) and “professional ranks and titles” (OR:0.930, $P=0.049$).

Discussion

China's COVID-19 epidemic has experienced the following stages by the time axis to the end of August 2020: prevention and control outbreaks in Wuhan city and Hubei province (from 2019 to March 2020), prevention and control overseas imported and associated cases (since April 2020 to date), and control local outbreaks in Beijing, Dalian and Urumqi city (since early June 2020 to date) [14-16]. During the time of our investigation, the outbreak in Wuhan city has been already controlled, and the outbreak of Xinfadi wholesale market in Beijing have not yet begun. We did the investigation in this context and found out that the HCWs in Beijing only have a little more above moderate willingness to get the future COVID-19 vaccination, nearly one third of the respondents stated they would not or unsure. This is particularly surprising in a city where facing COVID-19 continuously attacking and even occurred local outbreaks in the past months, as well as historical suffering from huge SARS impact [17].

Two factors were found with strongly associated with intention to accept vaccine, which were “wanted the vaccine free of charge” and “believed vaccine approved for license have been fully evaluated in clinical trials”. Other positive associated factors were mainly about perception of the disease, including epidemic situation prognosis, disease severity, self infection risk, disease can be prevented by vaccine, etc., which were consistent with the common sense and logic of willingness to vaccinate. Concerns about the safety and effectiveness of vaccines were similar with influential factors previously reported in pandemic influenza A (H1N1) vaccine studies [12, 18-20]. Our study also found only slightly more than 60% of the respondents agreed that the vaccine was safe and effective during the investigation. What's more, more than half of the respondents' judges of epidemic trend were apparently not consistent with the real situation. This means rooms still leaved for effective interventions to change the HCWs' perception to improve the acceptance of the COVID-19 vaccine.

Negative associated factors including “highest academic degree” and “professional ranks and titles” were not strong but worthy of attention. This may be due to higher correct cognition of the disease and vaccine, or be more confident with the effect of Non-Pharmacological control interventions, so they tended to hold more cautious attitudes to accept a new vaccine. HCWs are the high-risk group of infection, the bridge group of hospital infection transmission, and also the professional playing key roles to recommend vaccine to the general population. The reason may need to further study to avoid the negative of authority effect on vaccination.

Reviewing the pandemic influenza A (H1N1) vaccination process in 2009, the reported willingness of HCWs were usually 13-89% in different studies while the actual vaccination rate is slightly lower [12]. In China, willingness of the HCWs were about 50-80% to get vaccination in the early and rapid rising period and dropped to 20-30% at the peak of the influenza A (H1N1) epidemic. One main reason is the public

thought the disease was not serious as expected [21]. Under the implementation of a free and voluntary influenza A (H1N1) vaccination strategy, the coverage rate of HCWs in Beijing were finally achieved 71% which were much higher than that of the general population 12.6% [22].

A successful vaccination strategy does not just protect the health of HCWs, but also limit the transmission between the health sector and the community. Measures may be recommended to improve HCWs' vaccination acceptance and encourage them play an exemplary role for the public: results of phase III clinical trials and post-licensed studies should continue to be published in peer-reviewed journals to maintain openness and transparency; evidence-based evaluation should be started, National Immunization Advisory Committee(NIAC), technical guidelines of Physicians Association and other ways should be made full use to provide authoritative information to HCWs; correct information should be ensure to transmit to the leaders and members of medical professional associations to mobilize them to participate in vaccination.

Conclusions

In summary, our study found that the HCWs in Beijing have a little more above moderate willingness to get the future COVID-19 vaccination before the completion of phase III vaccineclinical trials, and the willingness were strongly associated with the perception of whether the vaccine is free and safe. It suggested that free vaccination strategy should be considered to be implemented, hard work and effective measures should be taken immediately to remove barriers and convey correct information through appropriate ways to further enhance the awareness and improve acceptance of COVID-19 vaccination among HCWs in China.

Declarations

Ethics approval and consent to participate

The method of this study was performed in accordance with the Declaration of Helsinki. Ethical approval was sought and granted from the Institutional Review Board and Human Research Ethics Committee of the Beijing Center for Disease Prevention and Control (Ethical approval No. 2020 (25)). The research was carried out in strict accordance with the research plan approved by the ethics committee. We obtained subjects' informed consent before the start of the interviews.

Consent for publication

Written informed consent for publication was obtained from all participants.

Data availability statements

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests

All authors report no potential conflict of interest.

Funding statement

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The authors contribution

SLD participated in the conceptualization, data curation, formal analysis, methodology, project administration, writing - original draft; MR, LL, PXH contributed to the conceptualization, resources, data curation, formal analysis, methodology, writing-review&editing. WZZ, TT, WHH, LF, TJF, PXH, GX were involved in data curation and writing-review&editing. All authors read and approved the final manuscript.

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Tables

Table 1 Characteristics of the respondents

Variable	No.of HCWs,n=8040 (%)
Age group (years)	
18–30	2452(30.5)
31–40	3141(39.1)
41–50	1679(20.8)
51–60	705(8.8)
60-	63(0.8)
Gender	
Male	1578(19.6)
Female	6462(80.4)
Occupational cohort (three largest categories)	
Doctors	2836(35.3)
Nurses	3844(47.8)
Technicians	1360(16.9)
Ward type	
Fever screening clinic	384(4.8)
Respiratory department	555(6.9)
Emergency department	703(8.7)
Intensive Care Unit	528(6.6)
Medical imaging department	258(3.2)
Laboratory department	332(4.1)
Other	5280(65.7)
Hospital level	
Level I	2328(29.0)
Level II	2391(29.7)
Level III	3321(41.3)
Highest level of education	
Junior college or below	2653(33.0)
Undergraduate degree	4242(52.8)

Master degree candidate	975(12.1)
Doctoral candidate	170(2.1)
Professional ranks and titles	
Junior	833(10.4)
Intermediate	2909(36.2)
Senior	3713(46.2)
No title	585(7.3)
Underlying disease	
Yes	887(11.0)
No	7153(89.1)
Participated in the prevention and control of epidemic	5656(70.3)
Received other vaccines in the past 3 years	2822(35.1)
Seasonal influenza vaccine	1968(24.5)

Table 2 Perception to COVID-19 epidemic by HCW category					
Questions	Total,n=8040(%)	Doctors, n=2836(%)	Nurses, n=3844(%)	Technicians, n=1360(%)	P value*
Q1 Is it serious suffering from Sars-cov-2 infection?					
Not serious	33(0.4)	14(0.5)	10(0.3)	9(0.7)	<0.001
Little serious	307(3.8)	176(6.2)	95(2.5)	36(2.6)	
Serious	7700(95.8)	2646(93.3)	3739(97.3)	1315(96.7)	
Q2 Are you likely to be infected with Sars-cov-2?					
Unlikely	2135(26.6)	612(21.6)	1000(26.0)	523(38.5)	<0.001
Likely	4382(54.5)	1646(58.0)	2094(54.5)	642(47.2)	
Very likely	1523(18.9)	578(20.4)	750(19.5)	195(14.3)	
Q3 Are you at greater risk of Sars-cov-2 infection than other people?					
Agree	4627(57.5)	1815(64.0)	2277(59.2)	535(39.3)	<0.001
Disagree	1353(16.8)	480(16.9)	542(14.1)	331(24.3)	
Unsure	2060(25.6)	541(19.1)	1025(26.7)	494(36.3)	
Q4 If you got a Sars-cov-2 infection, do you think you will suffer from more serious symptoms than others?					
Agree	1247(15.5)	420(14.8)	643(16.7)	184(13.5)	0.004
Disagree	2034(25.3)	759(26.8)	912(23.7)	363(26.7)	
Unsure	59.2(59.2)	1657(58.4)	2289(59.5)	813(59.8)	
Q5 Do you think China's COVID-19 epidemic will come back?					
Agree	1850(23.0)	788(27.8)	850(22.1)	212(15.6)	<0.001
Disagree	2144(26.7)	726(25.6)	951(24.7)	467(34.3)	
Unsure	4046(50.3)	1322(46.6)	2043(53.1)	681(50.1)	
Q6 Do you think the global COVID-19 epidemic will last for a long time?					
Agree	3996(49.7)	1679(59.2)	1738(45.2)	579(42.6)	<0.001
Disagree	1141(14.2)	378(13.3)	539(14.0)	224(16.5)	
Unsure	2903(36.1)	779(27.5)	1567(40.8)	557(41.0)	

Q7 Do you think COVID-19 can be prevented by vaccination?					
Agree	5439(67.6)	1976(69.7)	2556(66.5)	907(66.7)	<0.001
Disagree	450(5.6)	181(6.4)	208(5.4)	61(4.5)	
Unsure	2151(26.8)	679(23.9)	1080(28.1)	392(28.8)	
Q8 Do you think the COVID-19 vaccine is safe?					
Agree	4929(61.3)	1727(60.9)	2363(61.5)	839(61.7)	0.902
Disagree	101(1.3)	34(1.2)	47(1.2)	20(1.5)	
Unsure	3010(37.4)	1075(37.9)	1434(37.3)	501(36.8)	
Q9 Do you think the COVID-19 vaccine is effective?					
Agree	5024(62.5)	1761(62.1)	2401(62.5)	862(63.4)	0.213
Disagree	48(0.6)	24(0.8)	20(0.5)	4(0.3)	
Unsure	2968(36.9)	1051(37.1)	1423(37.0)	494(36.3)	
Q10 How disturbed have you been in your work and life in the past 3 months?					
Not serious	253(3.1)	62(2.2)	137(3.6)	54(4.0)	<0.001
Little serious	1921(23.9)	588(20.7)	1003(26.1)	330(24.3)	
Serious	5866(73.0)	2186(77.1)	2704(70.3)	976(71.8)	
Q11 In the next period of time (6 months), how much do you expect the work and life to be disturbed by the epidemic?					
Not serious	792(9.9)	269(9.5)	377(9.8)	146(10.7)	0.638
Little serious	3746(46.6)	1308(46.1)	1802(46.9)	636(46.8)	
Serious	3502(43.6)	1259(44.4)	1665(43.3)	578(42.5)	
* χ^2 test.					

Table 3 Attitudes to COVID-19 vaccine by HCW category

Questions	Total,n=8040(%)	Doctors, n=2836(%)	Nurses, n=3844(%)	Technicians, n=(%)	P value*
Q1 Do you trust the propaganda of the official media?					
Believe	6462(80.4)	2385(84.1)	2983(77.6)	1094(80.4)	<0.001
Disbelieve	319(4.0)	99(3.5)	171(4.4)	49(3.6)	
Unsure	1259(15.7)	352(12.4)	690(18.0)	217(16.0)	
Q2 Do you trust professional staff' advices?					
Believe	7563(94.1)	2663(93.9)	3634(94.5)	1266(93.1)	0.266
Disbelieve	31(0.4)	13(0.5)	14(0.4)	4(0.3)	
Unsure	446(5.5)	160(5.6)	196(5.1)	90(6.6)	
Q3 If COVID-19 vaccine is approved for licenses, do you want it free of charge?					
Yes	6221(77.4)	2125(74.9)	3043(79.2)	1053(77.4)	<0.001
No	293(3.6)	127(4.5)	115(3.0)	51(3.8)	
Either is OK	1526(19.0)	584(20.6)	686(17.8)	256(18.8)	
Q4 Do you believe that COVID-19 vaccine approved for license has been fully evaluated in clinical trials?					
Believe	6431(80.0)	2220(78.3)	3118(81.1)	1093(80.4)	<0.001
Disbelieve	144(1.8)	75(2.6)	49(1.3)	20(1.5)	
Unsure	1465(18.2)	541(19.1)	677(17.6)	247(18.2)	
Q5 Will you go to get COVID-19 vaccination in the future?					
Yes	5395(67.1)	1849(65.2)	2636(68.6)	910(66.9)	<0.001
No	632(7.9)	269(9.5)	251(6.5)	112(8.2)	
Unsure	2013(25.0)	718(25.3)	957(24.9)	338(24.9)	
Q6 ^a Where would you like to get COVID-19 vaccination?					
Community vaccination clinic	1331(24.7)	478(25.9)	570(21.6)	283(31.1)	<0.001
Vaccination campaign organized by hospital	4064(75.3)	1371(74.1)	2066(78.4)	627(68.9)	

Q7 Will you advise your family members to get COVID-19 vaccination?					
Yes	5486(68.2)	1857(65.5)	2682(69.8)	947(69.6)	0.001
No	514(6.4)	213(7.5)	214(5.6)	87(6.4)	
Unsure	2040(25.4)	766(27.0)	948(24.7)	326(24.0)	
Q8 ^b Will you take your children to get COVID-19 vaccination??					
Yes	2643(61.9)	995(59.5)	1221(62.3)	427(67.0)	0.02
No	359(8.4)	154(9.2)	159(8.1)	46(7.2)	
Unsure	1267(29.7)	523(31.3)	580(29.6)	164(25.7)	
Q9 Who do you trust most offering COVID-19 vaccine information(multiple choice)?					
Official media	6862(85.3)	2379(83.9)	3346(87.0)	1137(83.6)	<0.001
Medical specialist	7134(88.7)	2427(85.6)	3511(91.3)	1196(87.9)	<0.001
Relatives and friends	317(3.9)	76(2.7)	155(4.0)	86(6.3)	<0.001
Colleagues	415(5.2)	96(3.4)	243(6.3)	76(5.6)	<0.001
Medical literature	4786(59.5)	1844(65.0)	2282(59.4)	660(48.5)	<0.001
Online media	492(6.1)	105(3.7)	264(6.9)	123(9.0)	<0.001
^a Only for those who are willing to be vaccinated					
^b Only for parents with children under 18 years old					
* χ^2 test.					

Table 4 Univariate association of variables affecting the intention to accept COVID-19 vaccination of HCWs in Beijing, China

Variables	Intention to accept vaccination			P value*
	Yes,n=5395(%)	No,n=632(%)	Unsure=2013,n(%)	
Gender				
Male	1077(68.3)	144(9.1)	357(22.6)	0.011
Female	4318(66.8)	488(7.6)	1656(25.6)	
Age group (years)				
18–30	1733(70.7)	140(5.7)	579(23.6)	<0.001
31–40	2096(66.7)	241(7.7)	804(25.6)	
41–50	1050(62.5)	178(10.6)	451(26.9)	
51–60	466(66.1)	71(10.1)	168(23.8)	
60-	50(67.1)	2(3.2)	11(17.5)	
Occupational cohort (three largest categories)				
Doctors	1849(65.2)	269(9.5)	718(25.3)	<0.001
Nurses	2636(68.6)	251(6.5)	957(24.9)	
Technicians and others	910(66.9)	112(8.2)	338(24.9)	
Ward type				
Fever screening clinic	234(60.9)	42(10.9)	108(28.1)	<0.001
Respiratory department	399(71.9)	37(6.7)	119(21.4)	
Emergency department	507(72.1)	50(7.1)	146(20.8)	
Intensive Care Unit	364(68.9)	37(7.0)	127(24.1)	
Medical imaging department	167(64.7)	20(7.8)	71(27.5)	
Laboratory department	176(53.0)	45(13.6)	111(33.4)	
Other	3548(67.2)	401(7.6)	1331(25.2)	
Hospital level				
Level I	2160(65.0)	301(9.1)	860(25.9)	<0.001
Level II	1675(70.1)	153(6.4)	563(23.5)	
Level III	1560(67.0)	178(7.6)	590(25.3)	
Highest academic degree				
Junior college or below	1903(71.7)	158(6.0)	592(22.3)	<0.001

Undergraduate degree	2784(65.6)	347(8.2)	1111(26.2)	
Master degree candidate	609(62.5)	105(10.8)	261(26.8)	
Doctoral candidate	99(58.2)	22(12.9)	49(28.8)	
Professional ranks and titles				
Junior	2618(70.5)	236(6.4)	859(23.1)	<0.001
Intermediate	1832(63.0)	263(9.0)	814(28.0)	
Senior	519(62.3)	96(11.5)	218(26.2)	
No title	426(72.8)	37(6.3)	122(20.9)	
Underlying disease				
Yes	533(60.1)	85(9.6)	269(30.3)	<0.001
No	4862(68.0)	547(7.6)	1744(24.4)	
Participated in the prevention and control of epidemic				
Yes	3849(68.1)	435(7.7)	1372(24.3)	0.019
No	1546(64.8)	197(8.3)	641(26.9)	
Received other vaccines in the past 3 years				
Yes	2098(74.3)	137(4.9)	587(20.8)	<0.001
No	3297(63.2)	495(9.5)	1426(27.3)	
Seasonal influenza vaccine				
Yes	1509(76.7)	89(4.5)	370(18.8)	<0.001
No	3886(64.0)	543(8.9)	1643(27.1)	

Table 5 Multiple logistic regression model for intention to accept COVID-19 vaccination of HCWs in Beijing, China

Variables	Univariate logistic regression model		Multiple logistic regression model	
	Odds Ratio(95%CI)	P value	Adjusted Odds Ratio(95%CI)	P value
Male gender	1.067(0.949-1.201)	0.279		
Age group				
Years≤40	0.819(0.741-0.905)	<0.001		
Years>40	1.221(1.105-1.350)	<0.001		
Occupational cohort (three largest categories)				
Doctors	0.876(0.795-0.965)	0.007		
Nurses	1.137(1.035-1.248)	0.007		
Technicians and others	0.990(0.874-1.120)	0.87		
Ward type				
COVID-19 related department	0.988(0.895-1.089)	0.802		
Other	1.013(0.918-1.117)	0.802		
Hospital level				
Level I	0.994(0.897-1.102)	0.911		
Level II	1.213(1.094-1.345)	<0.001	1.303(1.118-1.520)	0.001
Level III	0.853(0.777-0.938)	0.001	1.237(1.072-1.427)	0.004
Higher academic degree	0.804(0.754-0.858)	0.001	0.840(0.772-0.914)	<0.001
Higher income	0.852(0.790-0.919)	<0.001		
Professional ranks and titles	0.934(0.887-0.983)	0.009	0.930(0.865-1.000)	0.049
Underlying disease	0.709(0.615-	<0.001		

	0.819)			
Participated in the prevention and control of epidemic	0.866(0.783-0.958)	0.005		
Received other vaccines in the past 3 years	1.688(1.525-1.869)	<0.001		
Seasonal influenza vaccine	1.849(1.645-2.079)	<0.001		
Perception to COVID-19 epidemic				
Q1 Answer: "Serious"	1.753(1.409-2.182)	<0.001	1.368(1.030-1.817)	0.031
Q2 Answer: "Likely or Very likely"	1.123(1.012-1.247)	0.029		
Q3 Answer: "Agree"	1.205(1.097-1.324)	<0.001		
Q4 Answer: "Agree"	1.157(1.015-1.318)	0.029		
Q5 Answer: "Agree"	1.129(1.009-1.262)	0.034	1.346(1.150-1.576)	<0.001
Q6 Answer: "Agree"	1.319(1.202-1.448)	<0.001	1.208(1.062-1.373)	0.004
Q7 Answer: "Agree"	4.404(3.983-4.869)	<0.001	1.747(1.521-2.007)	<0.001
Q8 Answer: "Agree"	5.598(5.061-6.193)	<0.001	1.915(1.617-2.268)	<0.001
Q9 Answer: "Agree"	5.289(4.784-5.848)	<0.001	1.409(1.184-1.677)	<0.001
Q10 Answer: "Serious"	1.110(1.000-1.231)	0.049		
Q11 Answer: "Serious"	1.074(0.978-1.180)	0.137		
Attitudes to COVID-19 vaccine				
Q1 Answer: "Believe"	2.898(2.589-3.244)	<0.001	1.268(1.089-1.478)	0.002
Q2 Answer: "Believe"	6.326(5.134-7.795)	<0.001		
Q3 Answer: "Yes"	8.124(7.230-9.129)	<0.001	5.807(5.083-6.635)	<0.001
Q4 Answer: "Believe"	9.594(8.463-10.877)	<0.001	4.485(3.849-5.227)	<0.001

For the dependent variable "accept covid-19 vaccination", answer "Yes" is assigned as 1, answer "No" or "Unsure" is assigned as 0; if the independent variable is an ordered classification variable, it is set as dumb variables. All variables significant at $p < 0.1$ in univariate logistic regression could be selected in the final multivariable stepwise logistic regression analysis.