Acceptance and preference for COVID-19 vaccination in health-care workers (HCWs)

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Abstract

The objective of the present study is to reveal the acceptance and preference for the 2019 novel coronavirus disease (COVID-19) vaccination in health-care workers (HCWs). We performed an internet-based, region-stratified survey among 352 HCWs and 189 individuals in the general population enrolled on March 17th and 18th 2020 from 26 Chinese provinces. The HCWs developed a more in-depth understanding of SARS-Coronavirus-2 infection and showed a higher tolerance to the future vaccination than the general population. 76.4% of HCWs (vs. 72.5% in the general) showed their willingness to receive vaccination. Potential benefits from COVID-19 outbreak such as seeking influenza (65.3%) or pneumonia (55.7%) vaccination can be gained in HCWs. To estimate the relative effects of attributes influencing vaccination choice in the discrete choice experiment, 7 attributes (3 disease-relevant, 3 vaccine-relevant, and 1 of social acceptance) were identified as key determinants. Among them, disease trend (odds ratio, OR: 4.367 (95%CI, 3.721-5.126) for seasonal epidemic, OR: 3.069 (2.612-3.605) for persistent epidemic, with reference to disappearance in summer), social contacts' decisions (0.398: 0.339-0.467 for refusal, 0.414: 0.353-0.487 for neutral, with reference to acceptance) and high possibility of being infected (2.076: 1.776-2.425 for infection probability of 30%+) were significantly associated with increased probability of choosing vaccination in the HCWs. In contrast, for the general population, vaccine safety and social contacts' decisions were the most important predictors. For COVID-19 vaccination, education in HCWs should be taken as a priority, and further benefits of its recommendation to the general public will also be anticipated.

Keywords: COVID-19, Health-care workers (HCWs), Acceptance, Discrete choice experiment (DCE), Preference

Introduction

Originated from Wuhan in Central China in December 2019 and widely spread due to the highly contagious pathogen SARS-Coronavirus-2 (SARS-CoV-2) in a completely susceptible population, the 2019 novel coronavirus disease (COVID-19) has soon evolved to a global pandemic sweeping across over 144 countries, leading to 153 thousands cases and 5735 deaths, by 15th March 2020, accompanying with potentially substantial economic loss(1-3). The unspecified interventions such as social distancing and quarantine can slow down the spread of virus and flatten the epidemic curve(4); however, the COVID-19 epidemic will not stop unless herd immunity is well established within the population, which is usually gained by infection or vaccination. Although at least 40 pharmaceutical companies and academic institutions have launched their programs on vaccine development against SARS-CoV-2 infection and some of them have reached early phase clinical trials(5), the safety and vaccine efficacy should be fully understood before it can be used in the real world. Hesitancy usually arises when a vaccine is introduced to the public about its effectiveness and potential safety. Complacency of not getting infected, lack of confidence in the safety & effectiveness of vaccine and vaccination service system, convenience of seeking service and higher expense than expected could eventually reduce the possibility of accepting the vaccination(6, 7). Besides under a higher risk of getting infected by various pathogens such as influenza viruses and SARS-CoV-2 than the general population(8, 9), health-care workers (HCWs) are also vital in helping the vaccinees or guardians understand and accept the vaccination. The importance of HCWs' vaccination recommendation to the public in the decision-making process has been well documented and HCWs are one of the strongest influencers in vaccination decisions(10-12).

Discrete choice experiment (DCE) presents a series of choice sets. How people make trade-offs among different attributes and levels indicates the relative importance of these attributes in decision preference(13). However, there have been limited studies using DCE to explore the preferences for vaccination(14-16). In this study, we sought to report the expectation and acceptance of future COVID-19 vaccine in HCWs compared with the general population, and to further reveal the preferences for COVID-19 vaccination.

Materials and methods

Subjects and design

Study subjects are HCWs of 20-59 years old from hospitals, center for disease control and prevention (CDC) or health community centers. According to the total number of reported confirmed COVID-19 cases till 15th Mar, 2020(17), we divided all provinces in mainland China into two categories: (i) high-level epidemic areas with 1000+ cases including Hubei, Guangdong, Zhejiang and Henan, (ii) low-level epidemic areas with < 1000 cases.

On March 17th and 18th 2020, we initiated an online survey by snowball sampling via WeChat invitation. We firstly invited 20 individuals via a link to the survey, with 10 from area (i) and 10 from area (ii). Each of the enrolees was then asked to invite 20-30 subjects of their social contacts to fill out the online questionnaire. To compare how COVID-19 vaccination acceptance differed in HCWs from the general population, adult subjects without medical backgrounds were also invited in the study, enrolling about half of the number of HCWs subjects.

Data collection

The survey was carried out using a self-administered, anonymous questionnaire, which consisted of 5 sections: (i) Demographics information; (ii) seven items for knowledge of and attitude to SARS-CoV-2 infection including susceptible individuals, various health outcomes, sub-population who tend to die after being infected, effective treatment, virus mutation, epidemic trend (disappear in summer like SARS, seasonal epidemic like seasonal influenza, persistent chronic disease like tuberculosis), and possibility of getting infected; (iii) ten items for the acceptability of COVID-19 vaccination including the necessity, months to availability on the market, the most needed to be vaccinated, desire to receive the vaccination, the lowest effectiveness, the most serious adverse effects, the highest number of doses, and the highest expense that could be accepted, and the confidence in domestic manufactured vaccines; (iv) behaviours post epidemic including plans to receive seasonal influenza vaccine or pneumococcal vaccine and maintaining of other unspecified protective measures; (v) Preferences for vaccination decision. All the questions were based on evidence in existing literature. The SO JUMP, an online survey platform, was employed to conduct the online investigation (see Supplemental material 1 and 2).

Discrete choice experiment

Seven attributes were finally identified as the key determinants of vaccination decisions based on group discussion and pilot investigation: three disease-relevant attributes (probability of infection, severity and probability of death once infected, and trend of epidemic), three vaccine-relevant attributes (vaccine effectiveness, vaccine safety and out-of-pocket vaccination cost), and one attribute of social acceptance (Table 1). A fractional factorial design based on orthogonal arrays (ORTHOPLAN procedure, IBM SPSS Statistics) was used to select 16 hypothetical profiles derived from 648 (3×2×3×2×2×3×3) candidate attribute profiles. Then the selected profiles were randomly distributed to 8 choice sets, each comprised of two hypothetical profiles (Scenario A and Scenario B). For each choice set, all participants were invited to make their COVID-19 vaccination decisions from either scenario A or B. An extra choice set was established to identify subjects being potentially 'irrational' or unable to understand the choices, in which scenario A instead of B would be logically chosen for sensitive analysis.

Data statistics

In the equation below, β1-11 are random coefficients varied over individuals; X_i is a vector of alternative specific variables; β0 is a constant term, and Error is a random term following a type I extreme value distribution. A binary Logistic regression was employed to assess the preference weight (odds ratio, OR) for each attribute level in determining whether to get vaccinated or not.

$$C_{\text{vaccined or not}} = Error + \beta_0 + X_1\beta 1_{\text{Infection probability}_{(15\text{–}30\%/1\text{–}14\%)}} + X_2\beta 2_{\text{Infection probability}_{(>30\%/1\text{–}14\%)}} + X_3\beta 3_{\text{Case-fatality ratio}_{(3\%\text{-}15\%/<3\%)}}$$
$$+ X_4\beta 4_{\text{Trend of epidemic}_{(flu/sars)}} + X_5\beta 5_{\text{Trend of epidemic}_{(ptb/sars)}} + X_6\beta 6_{\text{Vaccine safety}_{(safe/uncertain)}} + X_7\beta 7_{\text{Vaccine effectiveness}_{(\geq 80\%/50\%\text{-}80\%)}}$$
$$+ X_8\beta 8_{cost_{(100/free)}} + X_9\beta 9_{cost_{(300/free)}} + \beta 10_{\text{Acceptance of social contacts}_{(\text{Encourage/ Neutral/no opinion})}} + \beta 11_{\text{Acceptance of social contacts}_{(\text{Refuse/ Neutral/no opinion})}}$$

Descriptive analysis was performed using SPSS Version 25.0 (IBM Corporation, New York, United States) and statistics DCE process was carried out in STATA 16. The study approval was obtained from the Institutional Review Board of Zhejiang Chinese Medical University (ZCMU) and anonymity was guaranteed to participants.

Results

Demographic characteristics

In total 561 of 583 subjects who were approached completed the online survey, yielding a response rate of 96.2%. Of the 561 eligible participants, 20 (3.56%) were excluded from the analysis (13 living outside of China, 7 out of age limit). We included 541 participants from 26 provinces in China in the analysis.

Approximately 303 (56%) of the respondents were from area (i) (Hubei, Guangdong, and Zhejiang), with 70 (23%) from Wuhan. The characteristics of gender and age were comparable between the HCWs (n=352, 65%) and individuals from the general population. Nearly 60% of the HCWs were females and 90% were well educated with a degree of bachelor or above (Table 2).

Knowledge on and attitude to COVID-19

Overall the HCWs developed a more in-depth understanding of the infection and disease than the general population. The majority of HCWs recognized that all age groups are susceptible to the novel virus (305, 86.6%), and there is an increased risk of death in infected individuals of the elderly or with chronic diseases (349, 99.1%). Nearly 90% of the HCWs believed that there have been slight mutations and 7% believed dramatic mutations of the virus. Of the 141 HCWs who reported their views for COVID-19 trend, 47.5% (n=67) believed it would diminish in summer, 44.7% (n=63) believed it would continue to spread periodically, and only 8% (n=11) believed that it would evolve to a chronic disease.

Regarding the risk of COVID-19, 66% of the HCWs thought they might be infected in future, which is higher than that in the general population (52%).

Expectation and acceptance of COVID-19 vaccination

As to the COVID-19 vaccine under development, 95% of the HCWs thought it is necessary. The HCWs showed a higher tolerance to the future vaccine. Compared with general population, the HCWs believed that more time is needed before the vaccine could be introduced into use, could accept lower least-protection, more servere adverse effects such as systematic reaction and allergic reactions, and more minor-lesions or severe lesions than general population (Table 2).

About half of HCWs (52.5%) believed that the COVID-19 vaccine by domestic manufactures would be better than those produced abroad, which is lower than the general population (65.6%). For the possible reasons that domestic vaccine could be inferior, about 60% HCWs chose the poor quality due to less strictly controlled production process, and 60% general individuals chose vaccine safety that could not be fully guaranteed. For all subjects, 80% agreed that it should be free of charge and nearly half could afford a cost of 100-299 RMB (14-42 dollars) for total doses. Three quarters of the HCWs would receive vaccination against COVID-19; however, nearly one fifth needed more information before they could finally make their decisions.

Protection adopted post epidemic

When the epidemic ends, about 70% HCWs would seek and receive vaccination against influenza or pneumonia. The HCWs would prefer influenza vaccination (65.3%) while the general population prefers the pneumococcal vaccination (58.7%). The subjects would reduce the frequency of going to the crowed (74%), keep washing hands frequently (96%), doing exercises (93%), and wearing mask (67%) in the future.

Vaccine preference actors

Seasonal epidemic (OR: 4.4) or persistence (OR: 3.1), social contacts' vaccination practice (OR: 2.4 and 2.5), high possibility of infection (>30%) (OR: 2.1), fee (OR: 2.1 and 1.7), vaccine effectiveness (OR: 1.8) and safety (OR: 1.5) have much stronger effects on the COVID-19 vaccination decisions than the infection possibility of 15%-30% (1.0) or severity (OR: 0.99) in the HCWs(Table3). This indicates that disease trend in the future and high possibility of being infected may increase the importance of disease-relevant attributes relative to vaccine-attributes in the decision-making of HCWs.

Similar or weaker effects of attributes on vaccination preference were found in the general population. However, general population seems to focus more on vaccine safety (OR:2.3), social contacts' decisions (OR:4.7 and 2.1) and case-fatality ratio (OR:1.3) than HCWs. Sensitive analysis based on 445 subjects shown in Table 4 indicates that similar effects were found for all choice sets for HCWs and the general population.

Discussion

Using an internet-based, region-stratified study from 26 provinces in China, we surveyed population's knowledge on COVID-19 and their attitude towards future vaccination in China. Compared with the general population, HCWs showed more tolerance on the adverse effects and the effectiveness of vaccine. Further potential benefits from the epidemic such as influenza or pneumonia vaccination can be gained from the epidemic. Disease trend, social contacts' decisions and high possibility of being infected are significantly associated with increased probability of choosing vaccination among HCWs, while for the general population, vaccine safety and social contacts' decisions are the most important predictors.

Most HCWs (3/4) showed their willingness to receive the COVID-19 vaccination after introduction, which, to a large extent, is due to the risk evaluation of infection and confidence in the effectiveness and safety of vaccine. HCWs had a much higher possibility of getting infected by the novel virus. For example, by Feb 11th, 2020, with 6 deaths, 1716 HCWs were reported to get COVID-19 in China(18). In our study, 66% of the HCWs believe they may be infected by the virus from close contacts with COVID-19 cases or daily contacts. The uncertainty in how the epidemic will develop also contributes to the risk evaluation - 60% HCWs in the study don't know the possible trend.

HCWs showed a positive attitude towards the vaccine. They can accept a lower effectiveness of 60-70% (just as seasonal influenza vaccine), more severe adverse effects, and a larger number of doses. HCWs are vital to the public's decisions to receive the vaccination, which can eventually increase vaccine coverage. Knowledge and acceptance were found to increase a HCW's willingness to recommended vaccination. One study in the UK reported that nurses with high knowledge scores were more likely to recommend influenza vaccine to their parents, and more willing to recommend vaccination to parents in the future(19). In a study on HPV vaccination in Cameroon, one of the most important factors considered amongst nurses when deciding to recommend vaccine is the understanding of the effectiveness and safety of the vaccine(20).

The percentage of HCWs willing to get vaccinated in our study during the epidemic of COVID-19 is much higher than that for the general population as well as previous results in a systematic review during the 2009 H1N1 pandemic (56.1% in the UK, 64% in the US and 54.7% in Australia)(21-23). Regarding the H7N9 vaccination, 59.5% of the general population in Beijing and 50.5% of the respondents in Hongkong China were reported to have the willingness to receive the vaccination(24, 25). However, most estimates of vaccination intention tend to be much greater than actual vaccine coverage estimates. In our study, nearly 20% of the HCWs and 25% of the general population are hesitant about COVID-19 vaccination, which may be a hinder to establish herd immunity within the population. A lack of preparedness for advising patients about vaccination and a lack of training are inhibiting factors for recommending the vaccine. For example, in a UK study with midwives, 76% agreed that they should routinely advise pregnant women on vaccination, but only 25% felt adequately prepared for the role(26). More efforts need to be made to increase the acceptance of vaccination in HCWs and the public.

Worried about poor vaccine quality produced by domestic manufacturers, certain HCWs may develop vaccine hesitancy, which could influence their own decisions and the vaccination recommendation to the public. In the study, the proportion of HCWs thinking 'domestic vaccine was inferior" is twice as in the public (7% vs. 3%). Basically, different from HCWs from western countries who are hesitant to the vaccine itself, 60% Chinese HCWs focus on the less strict quality control during the production instead of vaccines. Incidences of vaccines such as Changchun Changsheng Biotech reported in China in the past decade may lead to the decline of confidence in domestic vaccines among the Chinese including HCWs(27, 28). Similar to human body's immune memory and reactivation in the way vaccine works, HCWs or the public will show much more grief and indignation towards the future COVID-19 vaccine if serious adverse events are reported after vaccine introduction. Under the newly introduced Vaccine Management Law came into effect in late 2019, the country will find a chance to improve domestic vaccines including vaccine research, production and mass vaccination campaigns.

Further potential benefits from COVID-19 epidemic can be gained, in that the epidemic is a sound health education against infectious diseases. Health protection including receiving more vaccinations as well as wearing mask were observed in our study. Different levels of knowledge and risk evaluation on SARS-CoV-2 infection might explain the difference between HCWs and the public in choosing vaccinations. Increased perception to influenza burden, indicated by insufficient supply of vaccine in recent years(29, 30), and the assumption that the COVID-19 was an 'enhanced influenza' may contribute to the increased willingness to influenza vaccination in HCWs. The public begin to reach out for the pneumonia vaccine, partially in that they are scared with the COVID-19 that may seriously attack human's lungs(31).

Seasonal or persistent trend for COVID-19 epidemic is far more influential on vaccination choice than the infection probability or case-fatality ratio. This suggests that HCWs value much more the future trend than risk probability or consequences. The choice might be motivated by seasonal influenza vaccination, for which the virus circulates with seasonality annually. Different from HCWs, the general population in the study showed more attention to the COVID-19 vaccine safety. It is natural that the public usually completely or partially refuses the vaccination when an emerging vaccine is in use. Due to a lack of knowledge of vaccine, they have to make trade-offs between the adverse outcomes of vaccination and the disease burden, indicating education should be strengthened at this stage.

Social contacts, including the behaviors and attitude of relatives, friends and neighbors, play an importance role in decision for both HCWs and the general population. Uncertainty in the vaccination choice or being socially acceptable may contribute to the cautious or wait-and-see attitude. When vaccine safety or effectiveness is uncertain, external cues such as others' vaccination uptake will greatly help to strength or weaken the vaccination intent(16). On the other hand, individuals, especially in eastern countries, usually have a virtue of lack their own subjective judgments because of the cultural or traditional circumstances(32). The collectivism culture, which is vital in executing the social distancing activities during the first wave of COVID-19 epidemic in China, may hinder the vaccination when the COVID-19 vaccination is firstly launched.

Disease severity is not related to the vaccination decision in HCWs and exhibits a weak reversed association in the general sample (the upper CI for OR almost reaching 1.0). This is in accordance with what has been reported in other vaccine preventable diseases such as influenza(16). The emerging infectious disease of COVID-19, for its unknown origin, clinical therapy and possible transmissions, may weaken the vaccination decision in the study, which should be examined in future study.

There are several limitations in the present study. First, subjects were recruited and surveyed online instead of face-to-face interview, which may lead to potential bias for the DCE study. Second, we do not distinguish doctors and nurses in hospitals, health providers in the community or those in the center for disease control and preventions, who may have different levels of knowledge and choice decision.

Factors contributed to a vaccination decision include personal risk perception, vaccination attitude or motivation, information sources, access and demographic variables, as well as social influences and practical factors(33). For the future COVID-19 vaccination, an efficient and flexible vaccination system nationwide to ensure fair and affordable services is necessary. In this system, vaccine demand and hesitancy in various populations should be addressed. Multi-component interventions should be taken into consideration. Education in HCWs should be taken as a priority so that further benefit of their recommendation to the public could be anticipated.

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Declaration of interest statement

No potential conflict of interest was reported by the authors.

Supplemental online materials

Supplemental 1: The online questionnaire of COVID-19 vaccination acceptance and preference (in English)

Supplemental 2: The online questionnaire of COVID-19 vaccination acceptance and preference (in Chinese)

Tables & Figures

Table 1 Attributes and levels included in the discrete choice experiment

Attributes	Levels
Infection probability	1%-14%
	15%-30%
	>30%
Case-fatality ratio	<3%
	3%-15%
Trend of epidemic	Disappear in summer, like SARS
	Seasonal epidemic, like influenza
	Nonchronic, like tuberculosis
Vaccine safety	Safe with mild side effects
	Uncertain, it is a new vaccine
Vaccine effectiveness	50%-80%
	>80%
Out of pocket of the vaccination	Free
	RMB 100 (US $14.3)
	RMB 300 (US $42.9)
Acceptance of social contacts	Refuse
	Neutral/no opinion
	Encourage

Table 2 Characteristics of the study subjects and acceptance of COVID-19 vaccine

		Total	HCWs	General	X^2	p
Area	Area (i)	303(56.0)	170(48.3)	133(70.4)	24.321	<0.001
	Area (ii)	238(44.0)	182(51.7)	56(29.6)		
Gender	Male	230(42.5)	145(41.2)	85(45.0)	0.719	0.396
	Female	311(57.5)	207(58.8)	104(55.0)		
Education	Maser or above	149(27.5)	114(32.4)	35(18.5)	65.057	<0.001
	Bachelor	276(51.0)	199(56.5)	77(40.7)		
	Low than bachelor	116(21.4)	39(11.1)	77(40.7)		
Age group	20-29	212(39.2)	130(36.9)	82(43.4)	4.834	0.184
	30-39	175(32.3)	112(31.8)	63(33.3)		
	40-49	106(19.6)	78(22.2)	28(14.8)		
	50-59	48(8.9)	32(9.1)	16(8.5)		
Vulnerable	All	463(85.6)	305(86.6)	158(83.6)	0.927	0.336
	Subgroup	78(14.4)	47(13.4)	31(16.4)		
Easily die after	The elderly or with chronic diseases	537(99.3)	349(99.1)	188(99.5)	0.175	0.676
infection	Other	4(0.7)	3(0.9)	1(0.5)		
Effective	No	478(88.4)	325(92.3)	153(81.0)	28.789	<0.001
drug	Yes	20(3.7)	15(4.3)	5(2.6)		
	No know	43(7.9)	12(3.4)	31(16.4)		
Virus variation	No	32(5.9)	14(4.0)	18(9.5)	20.861	<0.001
	Slight	454(83.9)	314(89.2)	140(74.1)		
	Dramatic	55(10.2)	24(6.8)	31(16.4)		
Trend of	Diminish	98(18.1)	67(19.0)	31(16.4)	13.219	0.004
COVID-19	Seasonal epidemic	79(14.6)	63(17.9)	16(8.5)		
	Constant epidemic	24(4.4)	11(3.1)	13(6.9)		
	No sure	340(62.8)	211(59.9)	129(68.3)		
Be infected	No	210(38.8)	119(33.8)	91(48.1)	10.65	0.001
in future	Possible	331(61.2)	233(66.2)	98(51.9)		
Necessary	Yes	517(95.6)	335(95.2)	182(96.3)	1.001	0.606
to vaccine	No	10(1.8)	8(2.3)	2(1.1)		
	Not sure	14(2.6)	9(2.6)	5(2.6)		
Time before	in 6 months	162(29.9)	96(27.3)	66(34.9)	8.612	0.035
in use	In 1 year	219(40.5)	144(40.9)	75(39.7)		
	in 1.5 year	69(12.8)	42(11.9)	27(14.3)		
	More	91(16.8)	70(19.9)	21(11.1)		
Receiving	No	20(3.7)	15(4.3)	5(2.6)	2.904	0.234
COVID-19 vaccine	Yes	406(75.0)	269(76.4)	137(72.5)		
	Not sure	115(21.3)	68(19.3)	47(24.9)		
Most doses	1	39(7.2)	28(8.0)	11(5.8)	9.582	0.048
	2	155(28.7)	109(31.0)	46(24.3)		
	3	138(25.5)	95(27.0)	43(22.8)		

	4	7(1.3)	3(0.9)	4(2.1)		
	Not sure	202(37.3)	117(33.2)	85(45.0)		
Least vaccine effectiveness	<60%	16(3.0)	8(2.3)	8(4.2)	12.178	0.007
	60-69%	247(45.7)	178(50.6)	69(36.5)		
	70-89%	152(28.1)	96(27.3)	56(29.6)		
	≥90%	126(23.3)	70(19.9)	56(29.6)		
Local reaction	No	20(3.7)	10(2.8)	10(5.3)	2.073	0.15
	Yes	521(96.3)	342(97.2)	179(94.7)		
Systematic reaction	No	227(42.0)	133(37.8)	94(49.7)	7.212	0.007
	Yes	314(58.0)	219(62.2)	95(50.3)		
Allergic reactions	No	342(63.2)	215(61.1)	127(67.2)	1.978	0.16
	Yes	199(36.8)	137(38.9)	62(32.8)		
Minor lesions	No	505(93.3)	321(91.2)	184(97.4)	7.515	0.006
	Yes	36(6.7)	31(8.8)	5(2.6)		
Severe lesions	No	530(98.0)	344(97.7)	186(98.4)	0.29	0.59
	Yes	11(2.0)	8(2.3)	3(1.6)		
Confidence domestic vaccines	Better than aboard	273(50.5)	168(47.7)	105(55.6)	13.016	0.005
	Similar	180(33.3)	130(36.9)	50(26.5)		
	Worse	27(5.0)	22(6.3)	5(2.6)		
	not sure	61(11.3)	32(9.1)	29(15.3)		
Worse	Low VE	5(18.5)	5(22.7)	0(0)	4.512	0.125
	Safety	7(25.9)	4(18.2)	3(60.0)		
	Quality	15(55.6)	13(59.1)	2(40.0)		
Free of charge	Yes	432(79.9)	276(78.4)	156(82.5)	1.304	0.253
	No	109(20.1)	76(21.6)	33(17.5)		
Highest fee	<100	167(30.9)	108(30.7)	59(31.2)	0.897	0.826
	100-299	281(51.9)	184(52.3)	97(51.3)		
	300-499	62(11.5)	42(11.9)	20(10.6)		
	>=500	31(5.7)	18(5.1)	13(6.9)		
Vaccination post epidemic	Influenza	69(12.8)	56(15.9)	13(6.9)	16.593	0.001
	Pneumonia	47(8.7)	22(6.3)	25(13.2)		
	Both	260(48.1)	174(49.4)	86(45.5)		
	None	165(30.1)	100(28.4)	65(34.4)		
Less to crowded	No	139(25.7)	86(24.4)	53(28.0)	0.84	0.359
	Yes	402(74.3)	266(75.6)	136(72.0)		
Wash hands frequently	No	23(4.3)	12(3.4)	11(5.8)	1.756	0.185
	Yes	518(95.7)	340(96.6)	178(94.2)		
Wear mask	No	177(32.7)	118(33.5)	59(31.2)	0.297	0.586
	Yes	364(67.3)	234(66.5)	130(68.8)		
Exercises	No	40(7.4)	26(7.4)	14(7.4)	0	0.993
	Yes	501(92.6)	326(92.6)	175(92.6)		

Table 3 Preference for COVID vaccination for HCWs and the general population(n=445)

Variables	HCWs (N=302)			General Population （N=143）		
	OR (95%CI)	SE	p	OR (95%CI)	SE	p
Infection probability						
1%-14%	1.000			1.000		
15%-30%	1.007(0.855-1.186)	0.084	0.933	1.012(0.808-1.268)	0.116	0.919
>30%	2.076(1.776-2.425)	0.163	***	2.007(1.600-2.517)	0.232	***
Case-fatality ratio						
<3%	1.000			1.000		
3%-15%	0.992(0.872-1.127)	0.065	0.899	0.783(0.649-0.943)	0.746	*
Trend of epidemic						
Dimish in summer, like SARS	1.000			1.000		
Seasonal epidemic, like influenza	4.367(3.721-5.126)	0.357	***	2.149(1.721-2.683)	0.243	***
Nonchronic, like TB	3.069(2.612-3.605)	0.252	***	1.609(1.261-2.054)	0.200	***
Vaccine safety						
Uncertain, it is a new vaccine	1.000			1.000		
Safe with mild side effects	1.541(1.354-1.754)	0.102	***	2.288(1.897-2.760)	0.219	***
Vaccine effectiveness						
50%-80%	1.000			1.000		
>80%	1.770(1.536-2.039)	0.128	***	1.788(1.461-2.189)	0.185	***
Out of pocket of the vaccination						
Free	1.000			1.000		
RMB 100 (US $14.3）	0.576(0.496-0.669)	0.044	***	0.787(0.632-0.979)	0.088	*
RMB 300 (US $42.9）	0.476(0.403-0.561)	0.040	***	0.584(0.459-0.744)	0.072	***
Acceptance of social contacts						
Encourage	1.000			1.000		
Neutral/no opinion	0.414(0.353-0.487)	0.034	***	0.484(0.389-0.602)	0.054	***
Refuse	0.398(0.339-0.467)	0.033	***	0.212(0.165-0.273)	0.027	***
Log likelihood	-2839.4509			-1354.136		
Number of obs	4832			2288		
Prob > chi2	***			***		
Pseudo R2	0.1522			0.1462		

Note, OR: Odds ratio, SE: standardized error.
* p<0.05 for statistical significance.
** p<0.01 for statistical significance.
*** p<0.001 for statistical significance.

Table 4 Preferences based on 9 choice sets (n=541)

Variables	HCWs (N=352)			General Population (N=189)		
	OR (95%CI)	SE	p	OR (95%CI)	SE	p
Infection probability						
1%-14%	1.000			1.000		
15%-30%	0.924(0.798-1.069)	0.069	0.286	0.859(0.714-1.034)	0.081	0.109
>30%	1.781(1.555-2.040)	0.123	***	1.373(1.149-1.642)	0.125	***
Case-fatality ratio						
<3%	1.000			1.000		
3%-15%	1.016(0.907-1.138)	0.059	0.782	0.825(0.710-0.959)	0.063	*
Trend of epidemic						
Dimish in summer, like SARS	1.000			1.000		
Seasonal epidemic, like influenza	3.436(2.996-3.942)	0.240	***	1.660(1.389-1.985)	0.151	***
Nonchronic, like TB	2.702(2.338-3.122)	0.199	***	1.422(1.170-1.729)	0.142	***
Vaccine safety						
Uncertain, it is a new vaccine	1.000			1.000		
Safe with mild side effects	1.602(1.429-1.796)	0.093	***	2.033(1.751-2.360)	0.155	***
Vaccine effectiveness						
50%-80%	1.000			1.000		
>80%	1.643(1.446-1.867)	0.107	***	1.593(1.344-1.887)	0.138	***
Out of pocket of the vaccination						
Free	1.000			1.000		
RMB 100 (US $14.3）	0.561(0.491-0.641)	0.038	***	0.670(0.561-0.800)	0.061	***
RMB 300 (US $42.9）	0.481(0.416-0.555)	0.035	***	0.619(0.513-0.748)	0.060	***
Acceptance of social contacts						
Encourage	1.000			1.000		
Neutral/no opinion	0.437(0.378-0.504)	0.032	***	0.509(0.424-0.612)	0.048	***
Refuse	0.448(0.390-0.515)	0.032	***	0.335(0.278-0.404)	0.032	***
Log likelihood	-3683.9401			-2076.8354		
Number of obs	6336			3402		
Prob > chi2	***			***		
Pseudo R^2	0.1612			0.1193		

Note, OR: Odds ratio, SE: standardized error.
* p<0.05 for statistical significance.
** p<0.01 for statistical significance.
*** p<0.001 for statistical significance.

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