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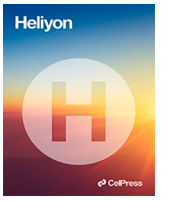

Research article

Employees' seeking preference towards influenza vaccination in organization: A discrete choice experiment in China

Binshan Jiang [a,1], Mu Li [b,1], Peixi Dai [c], Yanlin Cao [a], Yuxi Liu [a], Xiang Shu [b,**], Weizhong Yang [a,***], Luzhao Feng [a,*]

[a] School of Population Medicine and Public Health, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, 100730, China
[b] China National Biotec Group Company Limited, Beijing, 100024, China
[c] Division of Infectious Disease, Chinese Center for Disease Control and Prevention, Beijing, 102206, China

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ABSTRACT

To clarify the preferences of employees seeking influenza vaccination, a discrete choice experiment aims to understand the essential factors that close the gap between intention and behavior. A total of 866 employees with vaccination willingness willing to participated in a discrete choice experiment (DCE) between October 31st and December 6th' 2022 in China including the following attributes: price, vaccination setting, appointment mode, and service time. The data was analyzed using mixed logit models. Employees from smaller enterprises were more likely to get vaccinated collectively. For employees willing to get the influenza vaccine, 95.08 % of their choice was dominated by price. Employees' behavior varied according to their socioeconomic characteristics. Only female employees strongly favored work-site-based vaccination. Price was the primary factor considered by employees for getting the influenza vaccine. DCE would help to develop influenza vaccination intervention targeted at different groups in future studies.

1. Introduction

Surveillance statistics suggested that influenza picked up in northern hemisphere since October 2022 [1]. Meanwhile, influenza activity was predicted to increase to reach or even exceed the level in the same period before COVID-19 pandemic in 2022/2023 season, especially when facing risks arising from immunity debt [2,3]. Influenza vaccination is acknowledged as the most effective way to prepare for potential circulation of influenza viruses [3]. Unfortunately, influenza vaccine coverage is generally lower in the working-age population than in fragile people, with less attention to the group in previous studies meanwhile [4,5]. Low influenza vaccination rates of employees result in billions of avoidable disease burden and economic losses to individuals and society each year [6,7].

Even if people who say that are willing to get vaccination often do not mean it, while employees who wish to get vaccinated stumble over inaccessibility, inconvenience, or unaffordability. According to the framework proposed by World Health Organization (WHO) position paper of behavior and social drivers (BeSD) of vaccine uptake, external drivers help to close the intention-behavior gap [8].

* Corresponding author.
** Corresponding author.
*** Corresponding author.
E-mail addresses: shuxiang1@sinopharm.com (X. Shu), yangweizhong@cams.cn (W. Yang), fengluzhao@cams.cn (L. Feng).
[1] Contributed equally to this study.

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Specifically, social process and favorable conditions can lead people to keep their vaccination promises [9]. Work-site-based vaccination has provided a sound solution which has been widely accepted by healthcare workers. Research conducted on worksite influenza vaccination revealed significant differences among employees, vaccination rates increased from 2.0 to 5.7 times in different occupations [10–12]. It was reported that each employee would have saved USD 89–327 if they had access to workplace influenza vaccination [13]. Limited evidence illustrated the effectiveness of such service in Chinese employees in the available literature, and little is known about the triggers of individual and group level for vaccination behavior among people with favorable inclination.

In this study, we tried to modify the obstacles standing between intention and behavior. The State-owned Assets Supervision and Administration Commission of the State Council (SASAC) announced that state-owned enterprises (SOEs) should push forward the influenza vaccination for employees to ensure Chinese infrastructure and pillar industries functioning. Taking an advantage of a real-world decision, discrete choice experiment (DCE) studies have been widely employed to assess preferences for vaccine features such as effectiveness, adverse effects, immunization schedule and protection period, but seldom engaged into improving immunization service [14–17]. Therefore, we tried to identify the Chinese employees' preferences of different deliveries of immunization service within organization when they accepted influenza vaccine. Furthermore, we explored the implications of the kind of influenza vaccination program developed considering the characteristics of socioeconomic status and different size of enterprises.

2. Materials and methods

2.1. Study setting

We conducted our study accompanied with an influenza vaccination campaign in SOEs during the 2022/2023 season. To protect employees from influenza, SOEs offered influenza immunization services for their employees under the support of SASAC. SOEs which responded to the call could arrange for their employees to be vaccinated at their workplace, if available, or at assigned vaccination sites by contacting vaccination clinics. We only examined the service preference of SOE employees that were willing to get influenza vaccination through made the survey at vaccination sites.

2.2. Attributes and levels of immunization services

DCEs have an advantage of presenting participants with a series of choice scenarios; they are asked to choose between two or more alternatives with simultaneously varying attribute levels [16,18]. We developed the attributes for the DCE and the construction of the DCE scenarios combining Chinese SOEs actual conditions based on a three-step process. First, we conducted a literature search of vaccination studies that used DCE. Focusing on our research purpose emphasizing on service delivery mode, we gathered attributes belonging to practical issues domain in the BeSD framework. These attributes were: vaccination setting or location [19–22], distance [23,24], vaccination appointment [20,25], service time [24,26], waiting time at vaccination site [25,26], means of information provided prior to vaccination [26,27], and price [28,29]. Then, a focus group discussion took place among five policy makers and experts to screen, rank and reduce the 7 extracted attributes and levels that fit the influenza vaccine based on this study purpose. Four attributes were eventually selected: 1) vaccination setting; 2) appointment mode; 3) service time; 4) price. Table 1 provides a description of attributes and levels.

Table 1
Discrete choice experiment attributes, descriptions, and levels.

Characteristic	Description	Levels	Anticipated utility form
Price	The amount of money self-paid for influenza vaccination		Linear
		0 RMB/dose	
		180 RMB/dose	
Vaccination setting			Non-linear
	Medical setting, references to community health centers, immunization clinics or departments, and local Centers for Disease Control and Prevention	Immunization clinics	
	Community setting, references to stadium, community centers workplaces, or other non-medical settings	Mobile vaccination unit	
Appointment mode	The mode of immunization service appointment arranged		Non-linear
	No scheduling required	Drop-in	
	Vaccination appointments made by yourself	By individual	
	Vaccination appointments made by your organization	By group	
Service time	The service days in a week		Non-linear
		Weekdays	
		Weekends	

Since the survey was designed for employees, when the mobile vaccination unit and collective appointment showed up together, the description was present as work-site-based and by company, respectively.

2.3. Statistical design of DCE

The design of a DCE refers to the number and composition of choice sets showed to each participant. Once attributes and relevant levels were identified, we used Ngene to construct a Bayesian D-efficient design. This version of design was presented to 63 respondents from two companies, but not included in the formal data collection. One-to-one interviews were then conducted randomly to gather feedback on the comprehensibility of survey questions. This pilot study had two primary objectives: a) confirming the attributes and the number of each set of choices, b) generating prior parameters for the final design. We found high non-response rate and majority of respondents experienced too many choices as a burden.

Each choice set was composed of two unlabeled immunization services and an opt-out option. Adding opt-out to the choice set was deemed necessary since influenza vaccination was not compulsory for employees and on-site vaccination was provided by SOEs voluntarily. In the final design, one attribute had three levels, and the other three had two levels; thus, the total number of alternatives was 24 ($=3\times2^3$). Based on the experience from the pilot study, presenting all alternatives to each participant may decrease response efficiency; a fractional factorial design using orthogonality was constructed by Ngene [30]. A set of 12 choice sets was selected based on orthogonality and grouped into four blocks, so the number of choices that each participant needed to complete was limited to three.

2.4. Choice context and survey design

The questionnaire started with an explanation of the purpose of the survey together with a short background to the potential risk of influenza in China and the necessity to get influenza vaccination.

To receive thoughtful responses, a warm-up task was added before the set of three experimental tasks. The warm-up task was designed as a forced choice (i.e. without opt-out option) in order to familiarize the respondents with the DCE. It was dominated by a service profile with lower price and keeping other attributes' level constant, which should be made an unambiguous choice by rational respondents. The formal three choice sets of the DCE were presented graphically and textually. Each choice set was laid out on a separate page, and respondents were asked to select which of the two offered services they would prefer or if they would rather opt for neither of them. They could only click through to the next page after confirming their choice. An example of a choice task was shown in Supplementary Fig. 1 (translated into English, originally in Chinese).

The following socio-demographic data about the participants were enquired after the DCE choice tasks: gender, age, education level, personal income level, whether they knew where to get influenza vaccine or not, influenza vaccination history, perceived severity of influenza, and perceived importance of influenza vaccine.

2.5. Sample and data collection

The survey was conducted from October 31 to December 6, 2022. The sample size was calculated according to the rule of thumb proposed by Johnson and Orme [31], which suggests that the sample size required for the main effects depends on the number of choice tasks (t), the number of alternatives (a), and the largest number of levels for any of the attributes (c) according to the equation: $N>\frac{500c}{t\times a}$. Thus, the minimum sample size of this DCE should be 167. A two-stage sampling was used to select respondents. After randomly selected companies from both vaccination settings, a convenient sampling method was used in each company. Informed consent was obtained at the beginning of the survey, and those who refused to provide consent would not have access to the survey. Respondents were randomly assigned one of the four blocks of choice sets. To control for ordering effects, and the order of the three choice tasks and the four service characteristics was randomized across participants.

2.6. Analytical model and estimation procedure

A mixed logit (ML) model is assumed that the preference parameters differ from person to person by considering both case-specific regressors and alternative-specific regressors [32]. Attributes were set as random parameters – each with a normal distribution – to allow for preference heterogeneity across participants [24]. It was preferable to the conditional logit (CL) model which only with alternative-specific regressors when DCE data do not satisfy the assumption of the independence from irrelevant alternatives property (IIA) ($p<0.05$) [33,34].

The model of primary interest was the main effects model. Participants' utility ($\boldsymbol{U_{ijt}}$) obtained from an option is assumed to be determined by fixed effects ($\boldsymbol{V_{ijt}}$) of observable variables (personal characteristics and attributes, $\boldsymbol{X_{ijt}}$) and random utility ($\boldsymbol{\varepsilon_{ijt}}$) for unobserved features:

$$\boldsymbol{U_{ijt}=V_{ijt}+\varepsilon_{ijt}=\sum\nolimits_t X_{ij}\times\beta+\varepsilon_{ijt}, j=1,2,3;\ t=1,2,3,4;}$$

wh*ere:* $\boldsymbol{\beta_t}$ refers to a preference parameters vector [35]. Under this assumption, respondent **i** will choose option **j** from the choice set **t** to achieve maximum utility, $\mathrm{U_{ijt}}$. The attribute for price was considered a continuous variable, and the rest of the attributes were considered categorical variables. To measure individual service preferences, we specified that following ML model: $\boldsymbol{V_{ijt}=\beta_0+\beta_{1i}\times price_{ijt}+\beta_{2i}\times vaccination\ setting(clinics)_{ijt}+\beta_{3i}\times vaccination\ setting(mobile\ unit)_{ijt}+\beta_{4i}\times appointment\ mode(by\ drop-in)_{ijt}+\beta_{5i}\times appointment\ mode(by\ individual)_{ijt}+\beta_{6i}\times appointment\ mode(by\ group)_{ijt}+\beta_{7i}\times serivce\ time(weekdays)_{ijt}+\beta_{8i}\times serivce\ time(weekends)_{ijt}}$, where: $\boldsymbol{\beta_0}$ is a constant term estimating the average preference for having a vaccine, but not captured by

the attributes; $\beta_{1i}, \beta_{2i} \ldots, \beta_{8i}$ is the regression coefficient, which reflects the direction and size of this factor's influence for respondent i. Assuming β_t to be normally distributed in the ML model, and 500 draws were taken using Modified Latin Hypercube Sampling.

When the utility function is specified to be linear in parameters, the marginal utility of an attribute is equivalent to its coefficient [32]. Therefore, willingness to pay (WTP) is derived as the ratio of the nonprice attribute coefficient to the price coefficient interpreted the monetary value of other attributes [24]:

$$WTP_m = -\frac{\beta_m}{\beta_1}, m = 2, 3, 4, 5, 6, 7, 8;$$

where: β_m stands for coefficient of nonprice attributes; β_1 stands for the coefficient of price.

In addition to the main effects model, interacted service attributes and respondent covariates allow for exploration of observed preference heterogeneity and are indicated as the mixed logit model with interactions and heterogeneity analysis [36]. To categorize the obtained responses, we considered the following six categories based on Akaike information criteria (AIC) and Bayesian information criteria (BIC): respondents' gender, age group (≤30 years, 31–39 years, ≥40 years), education level (high school/technical secondary school or below, college/undergraduate, graduate and above), personal income per month (<10,000 RMB or ≥10,000 RMB), knowledge of where to get influenza vaccination, and influenza vaccination setting (at workplaces or at vaccination clinics). The interaction effects using mixed logit model was modelled following the logit function:

$$\begin{aligned} U_{ijt} = {} & \beta_0 + \beta_{1i} \times price_{ijt} + \beta_{2i} \times vaccination\ setting(clinics)_{ijt} + \ldots + \beta_{8i} \times serivce\ time(weekends)_{ijt} + \beta_{9i} \times vaccination\ setting(clinics)_{ijt} \\ & \times appointment\ mode(by\ drop-in)_{ijt} + \ldots + \beta_{14i} \times vaccination\ setting(mobile\ unit)_{ijt} \times appointment\ mode(by\ group)_{ijt} \\ & + \beta_{15i} \times vaccination\ setting(clinics)_{ijt} \times (age\ group) + \ldots + \beta_{62i} \times serivce\ time(weekends)_{ijt} \times (survey\ setting), \end{aligned}$$

where: $\beta_{9i}, \beta_{10i} \ldots, \beta_{14i}$ is the regression coefficient for the interaction terms within attribute levels; $\beta_{15i}, \beta_{16i} \ldots, \beta_{62i}$ is the regression coefficient for the interaction terms between attribute levels and respondents' characteristics categorized above. Categorical variables were converted to effects coding. We considered magnitude of the utilities interpreted relative to the magnitude of utilities of other attributes [18].

Partial log-likelihood estimation was used to compare the relative impacts of service attributes by calculating how much each attribute contributes to the overall log-likelihood of main effects model [33,37]. This expressed the relative importance of the attributes of immunization service for employees by ML model. All models were estimated in the Apollo package for R statistical software.

3. Results

3.1. Utility rate of the SOE influenza vaccination campaign

The SOE influenza vaccination campaign covered 133 corporations. Among these, 33 corporations offered their employees a worksite-based vaccination, resulting in a utility rate of immunization service of 47.5 %. Corporations arranged vaccination at clinics, resulting in a utility rate of 25.1 %. And employees were offered at no cost, resulting in a utility rate of 44.6 %, while only 9.2 % in self-paid group, details shown in Supplementary Table 1. Classified by the size of SOEs, total uptake rates of micro, small, medium and large size enterprises were 77.8 %, 54.9 %, 43.7 % and 29.3 % respectively (Fig. 1).

3.2. Preference and WTP

A total of 553 employees out of 856 who were sent the questionnaire completed it. Except for 14 failing in the quality check or the warm-up task, 539 respondents were included in our final analysis, 65.7 % were male, and the mean age of respondents was 37.42

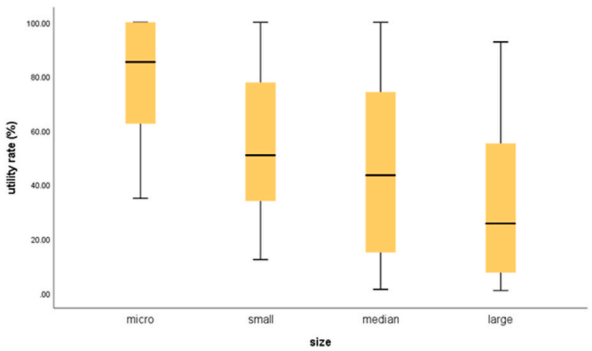

Fig. 1. Influenza immunization service utility rates according to the size of state-owned enterprises. The size of state-owned enterprises is classed by the number of employees. Micro, small, median, and large size refers to enterprise with 0–30, 31–100, 101–500, and more than 500 employees separately.

year, 143 (26.5 %) older than 45. All the respondents received the influenza vaccine this season, with 68.09 % received at their workplaces collectively and the rest at assigned clinics (Supplementary Table 2).

Since each questionnaire presented three choice sets for analysis, this resulted in 1617 DCE choices. Out of these, 784 (48.48 %) were counted for service A, 782 (48.36 %) for service B, and only 51 (3.15 %) for the opt-out option. Two thirds (363/539) of the respondents chose the free service consistently in three of their choice sets, indicating that the price of influenza vaccination was decisive. There was no significant effect in relation to which of the four survey versions a respondent received. Results of the basic panel ML model were shown in Table 2. The Chi-Square test of models' fitness showed that both were statistically significant ($p < 0.05$). The intercept was associated with a significant higher coefficient, implying that respondents placed higher preferences on provided service compared with opt-out. The basic model revealed that all levels of service had impact on respondents' choice of immunization service. Respondents were inclined to receive services provided at immunization clinics, with previous appointments, available on weekends and offered at a lower cost. The statistically significant standard deviation (SD) estimates in the main effects panel ML model indicated the presence of inter-respondent heterogeneity in preferences across attributes except vaccination setting. In addition, we used a CL model to calculate the preference estimates for influenza immunization service (Supplementary Table 3). The larger values of AIC and BIC, and log likelihood ratio test further confirmed that the ML model performed better than the CL model.

Willingness-to-pay represents the monetary value of non-price attributes, which is calculated by the price attribute. WTP with positive sign from one level of an attribute to another suggests that respondents want to pay extra for such level, while the negative means something was given in return to prompt respondents to accept on certain level. If the influenza vaccination appointment was made by their own or by the organization, respondents would be willing to pay 19.70 or 48.58 RMB, respectively. Although the statistic difference was marginal ($p = 0.057$), some people show willingness to pay for a weekend service. However, respondents did not express enthusiasm for vaccination delivery at mobile units ($p = 0.050$).

3.3. Preference heterogeneity

Taking interaction within attributes and between attributes and sociodemographic characteristics into account, further analysis was done to investigate to what extent preferences varied among different employees. Table 3 shows the results of interaction effects and the heterogeneity test using ML model. In the interaction effects model, only the price and the group appointment level stayed statistically significant. The significance results of SD were the same as the basic effect model which suggested that preference heterogeneity existed among those characteristics.

Several statistically significant interaction effects were observed in the ML model added respondent characteristics. The heterogeneity test indicated that middle age employees had higher preference for group appointment service (OR = 3.54), while those with high income were reluctant to accept it (OR = 0.36). For the interaction attributes, women employees were more likely to be vaccinated at community setting such as workplaces arranged collectively (OR = 3.56), while older employees were unwilling to accept this way of delivery (OR = 0.14). Regarding the service days, older employees preferred a weekend service (OR = 1.99), while those who were aware of vaccination sites or had experienced workplace vaccination, preferred a weekday service (OR = 0.61, 0.42 respectively).

3.4. Importance of attribution

Relative importance of specific attributes was generated based on the basic panel ML model by the partial log likelihood estimation. The price was found to have 95 % contribution to respondents' service choices, followed by the way of appointment, service days, and lastly, vaccination setting. Given the overwhelming impact of vaccination price, we compared the value of the remaining attributes

Table 2
Results of basic panel mixed logit model.

Attributes	Levels	Coefficient	Odds ratio (OR)	P	SD	P	Willingness to pay	P
Price (per 100 RMB)		−2.259	0.104	<0.001	1.540	<0.001	NA	NA
Alternative-Specific Constant		3.271	26.349	<0.001	NA	NA	102.74	<0.001
Vaccination setting								
	Immunization clinics	Reference						
	Mobile vaccination unit	−0.254	0.776	0.029	−0.064	0.410	−11.24	0.050
Appointment mode								
	By drop-in	Reference						
	By individual	0.445	1.561	0.006	0.700	0.123	19.70	0.010
	By group	1.097	2.997	<0.001	1.375	<0.001	48.58	<0.001
Service time								
	Weekdays	Reference						
	Weekends	0.239	1.270	0.049	1.038	0.001	10.60	0.057
Number of observations		1617						
Number of respondents		539						
Waldχ [2]/LRχ [2]		1980.2						
P>χ [2]		<0.001						
Akaike Information Criterion		1594.680						
Log pseudo-likelihood		−786.342						

Table 3
Interaction and heterogeneity analysis using mixed logit model.

Attributes	Levels	Attributes interaction model					Attributes and sociodemographic interaction model				
		Coefficient (β)	Odds ratio (OR)	P	SD	P	Coefficient (β)	Odds ratio (OR)	P	SD	P
Price (per 100 RMB)		−2.336	0.097	**<0.001**	−1.567	**<0.001**	−3.372	0.034	**<0.001**	1.834	<0.001
Alternative-Specific Constant		3.459	31.781	**<0.001**	NA	NA	3.464	31.954	**<0.001**	NA	NA
Vaccination setting											
	Immunization clinics	Reference					Reference				
	Mobile vaccination unit	−0.540	0.583	0.063	−0.408	0.308	−0.373	0.688	0.281	−0.543	0.133
Appointment mode											
	By drop-in	Reference					Reference				
	By individual	0.146	1.157	0.361	−0.704	0.150	0.269	1.308	0.379	0.788	0.069
	By group	1.003	2.726	**0.014**	−1.468	**<0.001**	2.238	9.378	**0.008**	1.111	0.009
	By group *[Age group: 31–40 years]	–	–	–	–	–	1.264	3.538	**0.037**	NA	NA
	By group*[Income: high level]	–	–	–	–	–	−1.027	0.358	**0.043**	NA	NA
Vaccination setting* Mode of appointment											
	mobile*by individual	0.528	1.695	0.190	NA	NA	−0.278	0.758	0.203	NA	NA
	workplace*by group	0.407	1.503	0.249	NA	NA	−2.243	0.106	**<0.001**	NA	NA
	workplace* by group *[Gender: female]	–	–	–	–	–	1.269	3.558	**0.048**	NA	NA
	workplace* by group *[Age group: 31–40 years]	–	–	–	–	–	−1.998	0.136	**0.007**	NA	NA
Service time											
	Weekdays	Reference					Reference				
	Weekends	0.229	1.258	0.098	−1.017	**0.024**	0.988	2.686	0.075	1.174	0.002
	Weekends*[Age group: >40 years]	–	–	–	–	–	0.688	1.989	**0.047**	NA	NA
	Weekends*[Know where to get vaccination: yes]	–	–	–	–	–	−0.489	0.613	**0.049**	NA	NA
	Weekends*[Survey setting: workplace]	–	–	–	–	–	−0.867	0.420	**0.014**	NA	NA
Waldχ [2]/LRχ [2]		1984.2					2082.1				
P>χ [2]		<0.001					<0.001				
Akaike Information Criterion		1594.76					1592.79				
Bayesian information criteria		1664.81					1921.48				
Log pseudo-likelihood		−784.379					−735.396				

Since there were 6 attribute levels in the interaction model (Table 1) and the dummies that were used to create the heterogeneity test terms were 6 (Table 3), the total number of interaction terms were 48. It means that out of this 48, only 8 (about 17 %) of the total interaction terms were statistically significant and hence included in Table 2. For lack of space, the remaining 40 interaction terms that were not statistically significant have been left out.

backwards. The results indicated that most respondents were concerned about the way of immunization service appointment (Table 4).

4. Discussion

It is generally acknowledged that there is a gap between willingness and vaccination behavior [5]. This study adds evidence about the influenza vaccination campaign by using DCE to explore preferences and WTP among corporate employees who had a desire to be vaccinated in China. Respondents stated a preference for free immunization service arranged by their organization at immunization clinics on weekends. Among attributes concerning practical issues, price was the predominant driving factor of designed services.

The SOEs' influenza vaccination campaign implemented amount to 133 corporations during 2022/2023 season. Among those, 32 corporations offered their employees a work-site-based vaccination for free, receiving an acceptance rate of 49.5 %, whereas this rate declined if the free service was provided at clinics, and further decreased when employees had to pay for immunization service. The range of utility rates of different modes of service delivery was in accordance with other worksite studies [10–12,38].

In line with previous studies, that price of influenza vaccine acted as the most influential factor is not difficult to perceive [10,39,40]. Since influenza vaccine have not been introduced into National Immunization Program (NIP) in China, charges have to be paid out of pocket. And such health behavior regards as an individual action depended by payer. However, it is still surprised that the extent employees put values on was unduly high. This finding may explain the more unsatisfactory coverage of work-age adult compared with vulnerable populations receiving free vaccines in provinces with sufficient budget.

According to overseas studies, waive fees would significantly lead to influenza vaccination rate increase whether it was supported by governments or employers [41–43]. Respondents in this survey had demand for influenza immunization services, 203 (37.7 %) employees thought it should be provided for free when asking about the reasonable price of influenza vaccine. The median of the maximum amount of WTP was 50 RMB/dose, while the market price (including the service fee) of the trivalent influenza vaccine was about 60–75 RMB/dose, and the quadrivalent one was about 135–180 RMB/dose differed from regions presently. Meanwhile, over sixty percent respondents showed their absolutely preference for free service in the DCE survey. Employees, held with vaccination willingness, took 100 RMB/dose as an affordable price, which indicating to introduce expense share mechanism between employees and variety parties. Through expanding financing sources and innovating medical security, subsidies would help to increase employees' influenza immunization service utility in order to promote the health equality.

Apart from the price, respondents placed more weight on the mode of service appointment than vaccination setting or time. Compared to a walk-in service, respondents inclined to make an appointment advance, especially which was arranged by their organization. This behavior preference could be explained by the strict implementation of non-emergency treatment appointment registration in China since the COVID-19 pandemic outbreak. To prevent nosocomial infections, patients made appointments every 30 min. This improvement was convenient to patients because it spared them of long waiting lines. In the vaccination program, the smaller the company, the higher the uptake rate, which indicated that vaccination campaign in small and micro companies would be more likely to succeed. An endorsement for collective appointment and action could be interpreted as a social norm within corporations. It may be interpreted as an interaction that drivers that belong to social processes domain present in the form of the practical issues domain. Collective vaccination is regarded no more individual action. Since vaccination is more a social health behavior than an individual behavior, employees in a same cluster tended to share common health characteristics and be more influenced by collective behavior [9,44,45]. The smaller the organization is, the stronger the connections among leadership and colleague are. Thus, when an individual was surrounded by colleagues with a positive attitude towards vaccination, social norm could weaken their vaccine hesitancy and push them into vaccination.

Contrary to statements in previous research, respondents showed their preference for mobile vaccination units. Presumably, employees have more confidence on traditional places of medical treatment such as immunization clinics or community health centers. The professional scenarios not only were regarded as a contribution to help them to take vaccination seriously, but also released their worries about adverse reactions. This is partly due to little experience of work-site-based vaccination for non-health related employees

Table 4
Relative importance scores of attributes.

Excluded Attribute	Log likelihood	Partial effect-change in loglikelihood	Relative effect-change in log likelihood	Cumulative (%)	Order of importance
Based on basic mixed logit model					
Price	−1291.4928	505.1509	95.08 %	95.08 %	1
Appointment mode	−805.5883	19.2464	3.62 %	98.71 %	2
Service time	−791.4344	5.0925	0.96 %	99.67 %	3
Vaccination setting	−788.1163	1.7744	0.33 %	100.00 %	4
Backward step model					
Appointment mode	−1307.2251	15.7323	84.19 %	84.19 %	1
Vaccination setting	−1294.0727	2.5799	13.81 %	97.99 %	2
Service time	−1291.8682	0.3754	2.01 %	100.00 %	3

Backward step model was based on the basic mixed logit model excluding the price attribute.

in China. As expected, employees are more available on weekends; however, influenza immunization services are currently provided one or two days a week, which poses barriers to work-aged adults. Consequently, employees acquainted with vaccination sites consider weekends services, while those that experienced work-site-based vaccination favored weekdays services. However, the results were not uniform among employees with different sociodemographic characteristics. For example, women take an interest in work-site-based vaccination. Income and age correlate with specific immunization services. These factors, to some extent, represented particular social condition and economic status, suggesting that immunization services would be delivered more effectively when tailored to the needs of target groups.

Before this survey, it was inconceivable that employees were indifferent to vaccination service at their workplace. Work-site-based vaccination smooths away practical difficulties such as finding vaccination sites; however, vaccination price was the dominant barrier, which had not been addressed appropriately in our study context. Meanwhile, a half day onsite service, which was designed for employees along with this survey, did not work for every employee if they were stuck in their work. In fact, that work-site-based vaccination conducive to uptake rate is generally conditional. Previous studies had already noted that work-site-based vaccination was no guarantee of an excellent participation rate [10,46–52], unless the services were provided free of charge and offered for several days at their work places [10,46,53,54]. In addition, funds from employers for influenza vaccination would be perceived as recommendation for potential welfare caring regarding employees' health as well as support to healthy behavior from organizations. The remedy offered by corporates both creates a human centered organizational environment and helps to overcome deficiency of health insurance or local finance.

This study was designed to help find an effective intervention to deliver influenza immunization service to employees. Considerations were confined to practical issues domain as strictly as possible, while interaction seems inevitable within and beyond this domain. Following to the BeSD position paper, interventions ought to be disaggregated to measure each component effect; however, one intervention, in social science, hardly guarantees to control other components, like randomized controlled trails do. It is sensible to clarify the differences in comparable portfolio interventions rather than each component to achieve satisfactory coverage in a cost-effective manner.

Limitations were present in this study. First, the survey was distributed along with the SOE onsite vaccination program, so our sample limited to SOE employees. However, the results may be generalizable to other units planning to provide influenza immunization service with favorable policies, which was the aim of our study. Second, we do not have information on the sociodemographic of nonrespondents. The anonymous nature of the survey did not permit us to compare respondents and nonrespondents, leading to a potential sampling bias. Third, since majority of respondents accepted free service during this study time, this ease of access might limit the interpretability of WTP results [55]. Our study showed that the DCE method is available and promised to be used among employees. Therefore, further DCE studies could be undertaken in other groups, such as private enterprise employees and even general population in China and abroad. The aim of the program was to improve convenience of the service, as thus, respondents' willingness to pay for the service provided a quantitative angle of preferences, which could inform similar decision-making in the future.

5. Conclusions

Overall, the results of our study indicate that DCE would be an applicable method to develop and measure influenza vaccination programs. The price factor is the most urgent problem to be solved to improve influenza vaccination rate among employees. Preferences for receiving influenza vaccine based on existing delivery modes (in medical setting and on weekdays) were strong, while collective actions incent employees to turn their intentions into actions. The lessons from our study may even be applicable to other populations. However, our study only examined the impact of practical issues on willingness employees. Whether it would work on hesitancy groups if improvements were made remains for further studies.

Data availability statement

The data that support the findings of this study are available from the first author and corresponding author upon reasonable request.

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Ethical approval

This study was reviewed and approved by the Chinese Academy of Medical Sciences and Peking Union Medical College (approval number: CAMS&PUMC-IEC-2022-019, approval date: March 14, 2022).

CRediT authorship contribution statement

Binshan Jiang: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software,

Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Mu Li:** Conceptualization, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft. **Peixi Dai:** Conceptualization, Data curation, Investigation, Methodology, Software, Supervision. **Yanlin Cao:** Data curation, Formal analysis, Investigation. **Yuxi Liu:** Data curation, Investigation, Visualization. **Xiang Shu:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision. **Weizhong Yang:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing. **Luzhao Feng:** Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing, Conceptualization.

Declaration of competing interest

The authors each individually and collectively declare there are no competing interests.

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Appendix A. Supplementary data

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