Preferences and willingness to pay for herpes zoster vaccination among Chinese adults: A discrete choice experiment

Yiqi Xia, Ming Wang, Mingzheng Hu, Yanshang Wang, Beibei Yuan, Dawei Zhu, Ping He

Submitted to: JMIR Public Health and Surveillance
on: July 26, 2023

Table of Contents

Preferences and willingness to pay for herpes zoster vaccination among Chinese adults: A discrete choice experiment

Yiqi Xia[1]; Ming Wang[1]; Mingzheng Hu[1]; Yanshang Wang[1]; Beibei Yuan[1]; Dawei Zhu[1]; Ping He[1] Prof Dr

[1]Peking University Beijing CN

Corresponding Author:
Ping He Prof Dr
Peking University
China Center for Health Development Studies, Peking University, 38 Xue Yuan Road, Haidian District, Beijing 100191, China.
Beijing
CN

Abstract

Background: The incidence of herpes zoster (HZ) is rapidly increasing that cause both clinical and economic burden in China. Very little is known about Chinese residents' HZ vaccine preferences and willingness to pay (WTP) for each vaccination attribute.

Objective: We aimed to elicit preferences of Chinese urban adults (aged ? 25 years) regarding HZ vaccination programs and to calculate WTP for each vaccination attribute.

Methods: In our study, we interviewed 2,864 residents in nine cities in China. A discrete choice experiment (DCE) was conducted to investigate the residents' preferences for HZ vaccination and to predict the uptake rate for different vaccine scenarios. A mixed logit model was used to estimate the preferences and WTP for each attribute. Seven attributes with different levels were included in the experiment and we divided the coefficients of other attributes by the coefficient of price to measure WTP.

Results: The vaccine effectiveness, protection duration, risk of side effects, place of origin and cost were proved to influence Chinese adults' preferences for HZ vaccination. Effectiveness of the HZ vaccine was the attribute that had the most predominant impact on residents' preferences, followed by protection duration. The residents were willing to pay CNY 974 to increase the vaccine effectiveness from 45% to 90% and they would barely pay for exchanging vaccination schedule from 2 doss to 1dose. It is suggested that the expected uptake could be promoted the most by 20.84% with an increase in protection rate from 45% to 90%.

Conclusions: Chinese urban adults made trade-offs between vaccine effectiveness, protection duration, place of origin, side-effects and cost of HZ vaccination. Vaccine effectiveness was the most important characteristic. The residents have the highest WTP to enhance the effectiveness of vaccines. To maximize HZ vaccine uptake, health authorities should promote vaccine effectiveness.

(JMIR Preprints 26/07/2023:51242)
DOI: https://doi.org/10.2196/preprints.51242

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Preferences and willingness to pay for herpes zoster vaccination among Chinese adults: A discrete choice experiment

Yiqi Xia[ab], Ming Wang[ab], Mingzheng Hu[ab], Yanshang Wang[ab], Beibei Yuan[b], Dawei Zhu[b*], Ping He[b*]

[a] School of Public Health, Peking University, 38 Xue Yuan Road, Haidian District, Beijing 100191, China;

[b] China Center for Health Development Studies, Peking University, 38 Xue Yuan Road, Haidian District, Beijing 100191, China;

E-mail address: 2211110248@stu.pku.edu.cn (Yiqi Xia); dzhu@pku.edu.cn (Dawei Zhu); phe@pku.edu.cn (Ping He).

* Corresponding author at: China Center for Health Development Studies, Peking University, 38 Xue Yuan Road, Haidian District, Beijing 100191, China.

Preferences and willingness to pay for herpes zoster vaccination among Chinese adults: A discrete choice experiment

Abstract

Background The incidence of herpes zoster (HZ) is rapidly increasing that cause both clinical and economic burden in China. Very little is known about Chinese residents' HZ vaccine preferences and willingness to pay (WTP) for each vaccination attribute.

Objective We aimed to elicit preferences of Chinese urban adults (aged ≥ 25 years) regarding HZ vaccination programs and to calculate WTP for each vaccination attribute.

Methods In our study, we interviewed 2,864 residents in nine cities in China. A discrete choice experiment (DCE) was conducted to investigate the residents' preferences for HZ vaccination and to predict the uptake rate for different vaccine scenarios. A mixed logit model was used to estimate the preferences and WTP for each attribute. Seven attributes with different levels were included in the experiment and we divided the coefficients of other attributes by the coefficient of price to measure WTP.

Results The vaccine effectiveness, protection duration, risk of side effects, place of origin and cost were proved to influence Chinese adults' preferences for HZ vaccination. Effectiveness of the HZ vaccine was the attribute that had the most predominant impact on residents' preferences, followed by protection duration. The residents were willing to pay 974 Chinese Yuan (CNY) (US dollars [USD] 151) to increase the vaccine effectiveness from 45% to 90% and they would barely pay for exchanging vaccination schedule from 2 doss to 1dose. It is suggested that the expected uptake could be promoted the most by 20.84% with an increase in protection rate from 45% to 90%.

Conclusions Chinese urban adults made trade-offs between vaccine effectiveness, protection duration, place of origin, side-effects and cost of HZ vaccination. Vaccine effectiveness was the most important characteristic. The residents have the highest WTP to enhance the effectiveness of vaccines. To maximize HZ vaccine uptake, health authorities should promote vaccine effectiveness.

Funding Major Project of the National Social Science Fund of China (No. 21&ZD187); National Natural Science Foundation of China (No. 71904005).

Keywords herpes zoster, vaccine preference, willingness to pay, discrete choice model

1. Introduction

Herpes zoster (HZ), or shingles, is caused by the reactivation of latent varicella–zoster virus (VZV) infection, which typically manifests itself as a localized, painful dermatomal rash[1]. The most common complication for HZ is post-herpetic neuralgia that can cause severe and burning pain and can greatly limit daily activities[2, 3]. The severity of HZ is a major public health issue worldwide, especially China[4], imposing a substantial burden on both patients and the healthcare system[5]. The global incidence of HZ was (3-5)/1000 person-years, which continued to rise by 2.5–5.0% every year[6, 7], and was (2.9-5.8)/1000 person-years in mainland China[5, 8]. In the United States, the economic burden for HZ could exceed $2 billion per year, resulting in more than 60,000 QALYs (Quality-Adjusted Life Years) lost per year[9]. A recent study conducted in Shandong province, China, assessed the disease burden for HZ as 59.99 DALYs (Disability-Adjusted Life Years) per 100 000 population[10]. Data gathered from Yinzhou district, China, showed the inpatient and outpatient cost per new-onset HZ was approximately 8116.9 CNY and 560.2 CNY, respectively[11].

Existing evidence supports that vaccination is the best way to reduce the incidence of HZ[12, 13]. In addition, a majority of studies found it to be cost-effective to vaccinate against HZ[14]. Currently, two types of HZ vaccines are commonly used globally, one of which is a recombinant zoster vaccine (RZV) available in China since 2020 and recommended for adults aged over 50 years[8, 15]. However, HZ vaccine uptake remains relatively low worldwide[15], along with the low willingness to pay (WTP) for HZ vaccines[8]. Vaccine decisions are often determined by individual's requirements and interests[16]. Whether to get vaccinated is, hence, based on internal and vaccine-specific characteristics, such as personal values[17], vaccine effectiveness[18] and cost[19], which can be interpreted as vaccine preferences[19]. Consequently, it is vital to consider the public's preferences for HZ vaccination.

Studies investigating the public's preferences for HZ vaccination are limited and fragmented. Though growing studies have tried to find the main barriers of HZ vaccine acceptance[20], only three published studies have examined HZ vaccine preferences among older people in the context of developed countries with discrete choice experiment (DCE), two from developed countries[21, 22] and one from developing countries[23]. Zhang et al[23] investigated the HZ vaccine preferences among older Chinses residents with a relatively small sample size (176 residents), but still, very little is known about HZ vaccine preferences among adults in developing countries. There is no comprehensive, nationwide survey about HZ vaccine preferences and WTP for different HZ vaccine attributes of the Chinese population across regions, though China is one of the prominent candidates in the global contest for vaccine research and development[24]. Moreover, it is worth studying adults under the age of 50 because the younger population may affect HZ vaccination by influencing their parents who are probably over 50 years old and the study may provide an opportunity to compare the differences of preferences for HZ vaccination between younger and older population[25].

In this study, we aimed to use DCE to explore the preferences for different attributes of HZ vaccination among Chinese urban population over 25 years old and to evaluate the residents' WTP for each attribute. We further calculated the probability of selecting different HZ vaccines to better describe the preference characteristics.

2. Methods

2.1 Discrete choice experiment

DCE, originating from mathematical psychology, is widely used to capture preferences in vaccination, since evidence showed that DCE yielded accurate predictions of actual choices[19, 26, 27]. When measuring vaccine preferences with DCE, individuals are given a series of alternative vaccine scenarios and are asked to select their preferred scenario[19, 28]. Within each scenario, the vaccines are described by their attributes (e.g. effectiveness) with variants of corresponding levels (e.g. effectiveness of 50% vs. 90%)[28]. By assessing individual's responses to different combinations of attribute levels, preferences for vaccine attributes are able to be obtained and described[29, 30].

Here, we developed a cross-sectional DCE survey following standard steps[31, 32] and administrated the experiments in July 2022 among adults aged 25 years and older in nine cites in China. The survey consisted of DCE questions and measures of respondents' characteristics (gender, age, educational level, marriage status, occupation and annual net household income in 2021). Questionnaires were conducted face-to-face by well-trained and eligible investigators (mainly medical school students).

2.1.1 Attributes and levels

Selection of vaccine attributes and their levels is key for ensuring the validity of DCE[33]. Since there's limited studies about Chinese residents' HZ vaccine preferences, we selected seven relevant HZ vaccination attributes and their levels based on literature about HZ vaccine preferences in China and other countries and Chinese residents' preferences for another vaccine[21-23, 28, 34]. We also referred to existing HZ vaccine marketing information and conducted a pilot study to ensure that the parameters in these references were applicable to conditions in China: (1) effectiveness (e.g. 45%); (2) protection duration (e.g. 2 years); (3) number of vaccine doses (e.g. 1 dose); (4) probability of influenza-like symptoms (e.g. 1%); (5) probability of skin reaction (e.g. 5%); (6) place of origin (e.g. imported); (7) price (e.g. 400 CNY [USD 62]). The details of the attributes and levels are displayed in Table 1.

Table 1 Attributes and levels for the DCE

Attribute	Levels for experimentally designed vaccines
Effectiveness	45%[a]、60%、75%、90%
Protection Duration(years)	2[a]、5、10、20
Number of vaccine doses	1 dose[a]、2 doses(2 months apart)
Probability of influenza-like symptoms	1%[a]、5%、10%、20%
Probability of skin reaction	1%[a]、5%、10%、20%
Place of origin	Imported、Domestic[a]
Price (CNY)	0[a]、400、800、1200

Notes: (1) [a] Denotes reference level.
(2) Effectiveness is the degree to which the prevalence of the disease decreases after vaccination, which can also be interpreted as protection rate. Suppose there are 1,000 people, and with everyone unvaccinated, 33 people might suffer from HZ in the next 5 years. If everyone is vaccinated against herpes zoster with a 45% vaccine effectiveness, the number of

people who will suffer from HZ in the next 5 years will drop to 18. And so on.
(3) Protection duration refers to the duration of immune protection against the infectious disease targeted after vaccination.
(4) Influenza-like symptoms refer to fever, fatigue, muscle pain, headache, and nausea that may occur in recipients after vaccination. With a 1% probability, 1 in 100 recipients may suffer from one or more of these symptoms; with a 20% probability, 20 in 100 recipients may suffer from one or more of these symptoms.
(5) Skin reactions refer to symptoms such as redness, swelling, hard nodules, pain, and itching at the vaccination site that may occur when the recipient is vaccinated. With a 1% probability, 1 out of 100 recipients may suffer from one or more of these symptoms; with a 20% probability, 20 out of 100 recipients may suffer from one or more of these symptoms.
(6) The number of doses refers to the total number of doses required to complete the vaccination process.

2.1.2 Experiment and questionnaire design

The vaccine scenarios in each alternative were determined by an experimental design using the attributes and levels in Table 1. Combining the seven attributes with each level results in 4096 (4*4*2*4*4*2*4) hypothetical HZ vaccination alternatives. Since it is not feasible for a single respondent to answer all these 4096 alternatives, we used an orthogonal experimental design to generate a sample of alternatives from all these 4096 alternatives[35, 36]. Orthogonal designs are more intuitive, require less choice sets and thus shorter questionnaires than efficient designs with the same amount of participants, an orthogonal design was used to counterbalance a more precise estimation of the coefficients and less choice sets[28, 37]. Thirty-two choice questions were shown to sufficiently estimate all the main attributes. We used a blocked design[38] to further divide thirty-two choice tasks into four versions of questionnaires containing eight choice sets each, which avoided lower response rate and/or lower response reliability caused by presenting a single individual with a large amount of choice sets. Each choice set presented two alternative vaccines in terms of seven attributes and an option of no HZ vaccination (Figure 1), a full version of questionnaires is presented in appendix file A. To specify the attributes, each questionnaire started with a detailed description of the attributes and their levels. Additionally, the well-trained investigators were told to explain the meaning of each attribute and to ensure the comprehension of the respondents before filling in the questionnaire. During the filling process, the respondents could ask questions about the attributes at any time.

2.1.3 WTP for the attributes

Seven types of attributes were identified to be potentially important to HZ vaccination choices, including the price of the vaccine that allows us to generate estimates of WTP for each vaccine attribute[39]. In other words, we could obtain the individual's WTP for desirable attributes and analysis the effect of changing attribute levels on WTP indirectly with the price attribute in the DCE questionnaire through the ratios between the coefficients of the price (cost) attribute with the other HZ vaccination attributes [30]. For example, the WTP for switching the protection duration to 5 years from the reference level (2 years) equaled the coefficient of the variable 'duration 5 years' dividing the coefficient of the variable 'price'. The levels of the cost attribute may inevitably impact on the WTP estimates though, we tried to avoid this problem by setting the levels rigorously according to literature[40].

2.2 Study population

2.2.1 Survey sampling

A two-stage random sampling method was adopted. In the first stage, nine cities were selected according to GDP per capita and the number of permanent urban residents (except Tibet and Xinjiang) using probability-to-size sampling method (PPS), including five cities in eastern China (Beijing, Shenzhen, Weifang, Shaoxing and Changchun), two cities in central China (Wuhan and Zhengzhou) and two cities in western China (Nanning and Zunyi). In the second stage, a high and a low economic level district (county) were selected in each city, respectively, and two community health service centers or township health centers were then selected in each district (county).

We recruited respondents randomly with acknowledgement after arriving at the health service centers. Eligible respondents were aged ≥ 25 years, living in China, without cognitive impairments and able to read and understand Chinese[21, 33]. A pilot study was conducted among 300 residents in Beijing in July 2021 to examine whether the survey was acceptable, well-understood and valid.

2.2.2 Sample size

Initially, we calculated the minimum sample size according to a rule of thumb suggested by Orme[41] and found a sample size of 83 in each district (county) would be desirable for the main effects model. As a result, we decided to choose 300 individuals in each city, which exceeded the desirable sample size and comprised a sample size of at least 2700 random selected residents in nine cities. We guaranteed the respondents' voluntary participation and privacy and verbal consent of the respondents was obtained. The investigators gave a detailed explanatory statement to each respondent about the study.

2.3 Statistical analysis

The DCE results were estimated by taking each choice among the three options ('two HPV vaccination' alternatives and a 'no HPV vaccination' alternative)[28]. A mixed logit model was employed to analyze DCE data[42]. We checked the convergence of the model with all parameters randomly distributed, 500 draws used and seed set to 12345 for reproducibility. The utility equation can be expressed as follows:

$$V=\beta_0+\beta_1 EFFECTIVENESS\_60\%+\beta_2 EFFECTIVENESS\_75\%+\beta_3 EFFECTIVENESS\_90\%+\beta_4 DURAT \quad (1)$$

where V is utility from each choice. β_0 is a constant reflecting respondents' preferences for receiving HZ vaccination relative to 'no HPV vaccination'. β_1–β_{15} are coefficients of the attributes indicating the weights relative to their reference

levels, where larger values of β indicate greater utility and more preferred attributes. ϵ is a random error term. We regulated the statistical significance of a coefficient as p-value ≤ 0.05 and we expected all attributes to be statistically significant. The sign of a coefficient reflects whether the attribute has a positive or negative effect on vaccine preferences. In our assumption, the estimated attribute levels of 'SCHEDULE' and 'INFLUENZA_LIKE_SYMPTOMS' and the attribute 'PRICE' would have a negative sign and the signs of other coefficients would be positive. The price attribute was treated as a continuous variable, while other attributes were dummy coded[43]. We also explored the preferences for HZ vaccination between different age, sex and income.

To investigate the WTP for each attribute, the monetary value for other attributes was calculated by the ratios between the coefficients of out-of-pocket cost (price of the vaccine) with the other HZ vaccination attributes[34]. It can be interpreted as a trade-off monetary value to achieve an increase or a decrease in one level of an attribute. For instance, β_1/ β_{15} indicates how much the respondents were willing to pay for a vaccination with a 60% protection rate instead of the reference level of protection rate (45%), holding all other attributes unchanged. Confidence intervals of the WTP were calculated by bootstrapping[44].

We further calculated the probability of individuals choosing a vaccination with specified attributes to convey understandable information to policy-makers. The probability of choosing a vaccination program is defined as:

$$P=\frac{1}{1+e^{-V}} \quad (2)$$

where V is defined as in equation (1). The base case of the HZ vaccination program was at 45% protection rate, protection duration of 2 years, vaccination schedule of 1 dose, 1% risk of influenza-like symptoms, 1% risk of skin reaction and originated from domestic place, which was the combination of the reference level of each attribute (except for cost attribute). We presented these results in a 'tornado' graph to show the marginal effect of changing each attribute at a time relative to the base case, holding all other attributes constant[28, 34]. All heterogeneity were considered in the calculation of the mean uptake. We performed all statistical analyses in STATA 15.

2.4 Ethical Considerations

This study was approved by the Peking University Institutional Review Board (PU IRB) (IRB00001052-20062). We informed the respondents of the study's purpose and provided a statement that study data were anonymous before obtaining written consent. No financial compensation was offered to the subjects for their participation.

3. Results

3.1 Respondents

After the pilot study, we confirmed the acceptability and validity of the survey and mild changes were made to the description texts of the attributes in the questionnaire. Table 2 presents the respondents' characteristics. A total of 2,864 urban residents from nine cities consented and participated in the survey. Among them, 1,523 (53.18%) were from eastern region, 641 (22.38%) were from central China and 700 (24.44%) were from western region. The mean (±SD) age of the respondents was 48.14 years (±16.55), ranging from 25 to 95 years. Most respondents were female (60.96%), married (86.00%) and at least had a bachelors' degree (24.65%). Annual net household income in 2021 was evenly distributed and the majority of the respondents were manual labor (36.77%).

Table 2 Sociodemographic characteristics of the study respondents

	Frequency（N）	Percent (%)
City		
Eastern region	1523	53.18
Central region	641	22.38
Western region	700	24.44
Gender		
Female	1746	60.96
Male	1118	39.04
Age group		
Aged 25-39	1114	38.90
Aged 40-59	929	32.44
Aged 60 and above	821	28.66
Marital status		
Unmarried	252	8.80
Married	2463	86.00
Divorced or widowed	149	5.20
Education		
Primary and below	537	18.75
Middle School	588.	20.53
High school	581	20.29
Junior college	452	15.78
Bachelor's degree and above	706	24.65
Occupation		
Manual laborer	1053	36.77
Retiree	613	21.40
Unemployed	463	16.17
White collar and Professional	735	25.66
Annual net household income in 2021		
40,000 CNY (USD 6,202) and below	741	25.87
40,000 CNY (USD 6,202)-80,000 CNY (USD 12,403)	641	22.38
80, 000 CNY (USD 12,403)-120, 000 CNY (USD 18,605)	644	22.49
120,000 CNY (USD 18,605) and above	838	29.26

3.2 DCE results

Table 3 shows the regression results of residents' preferences for HZ vaccination. The results indicated that all attributes had an effect on residents' preferences for HZ vaccination ($P < 0.01$), except for vaccination schedules. The coefficient of vaccination (constant) was significantly positive, representing that on average the residents were more likely to vaccinate against HZ regardless of the attributes and levels described in the vaccine profile. It is suggested that the higher the protection rate, the longer the protection duration, the lower the risk of flu-like or dermal symptoms and the lower the cost, the more likely that the HZ vaccination would be preferred. The positive or negative signs were consistent with our prior hypotheses except that respondents preferred domestic HZ vaccine rather than imported one. The positive sign given to the coefficients protection rate and protection duration indicated that respondents preferred an HZ vaccination generating a higher degree of protection and a longer protection duration over an HZ vaccination with lower effectiveness and less years of protection. The negative signs for influenza-like symptoms and skin reactions indicated that respondents preferred HZ vaccines with lower probability of side-effects. The attribute with the greatest magnitude of association with HZ vaccine preference was effectiveness, followed by protection duration.

We presented subgroup analysis for different gender, age and net household income in 2021 in Appendix B. The trends and signs of preferences for various attributes of the HZ vaccines were consistent across different genders, age groups, and net household income levels. It was illustrated that the male cared more about side-effects than the female. The younger and older residents were more sensitive to most attributed than the middle-aged. The richer the residents the more they were concerned about the effectiveness and protection duration of the HZ vaccination, while the residents whose net household income in 2021 were less than 80000 preferred domestic vaccines more than residents with income more than 80000.

Table 3 Preference of attributes of HZ vaccines

Attributes	Coefficient (SE)	95% CI	
Constant (vaccination)	2.804 (0.152) ***	2.506	3.102
Protection rate (Ref.=45%)			
60%	0.958 (0.450) ***	0.870	1.046
75%	1.751 (0.577) ***	1.638	1.864
90%	2.746 (0.746) ***	2.600	2.892
Protection duration (Ref.=2 years)			
5 years	0.404 (0.446) ***	0.317	0.491
10 years	0.678 (0.495) ***	0.581	0.775
20 years	1.013 (0.500) ***	0.915	1.111
Number of vaccine doses (Ref.=1 dose)			
2 doses	-0.001 (0.300)	-0.059	0.058
Probability of influenza-like symptoms（Ref.=1%）			
5%	-0.162 (0.045) ***	-0.249	-0.074
10%	-0.166 (0.550) ***	-0.274	-0.058
20%	-0.272 (0.046) **	-0.362	-0.183

Probability of skin reaction (Ref.=1%)			
5%	-0.154 (0.042) ***	-0.236	-0.072
10%	-0.233 (0.049) ***	-0.329	-0.136
20%	-0.291 (0.046) ***	-0.382	-0.201
Place of origin (Ref.= domestic)			
Imported	-0.354 (0.037) ***	-0.427	-0.282
Cost	-0.003 (0.000) ***	-0.003	-0.002

Notes: (1) The attribute “effectiveness” was coded as “protection rate”.
(2) Normal distribution for random coefficients used on all attributes.
(3) The value of the omitted term equals the negative sum of the coefficients of the included attributes.
(4) SE= standard error; CI= confidence interval.
(5) ***Denotes $P < 0.001$, **$P < 0.01$, *$P < 0.05$.

3.3 WTP for the attributes

Based on the Table 3, respondents showed their WTP to achieve an improvement in one level of a HZ vaccination attribute in Table 4. When the vaccine protection rate increased from 45% to 60%, 75% and 90%, the respondents' WTP for HZ vaccine increased by 340 CNY (USD 53), 621 CNY (USD 96) and 974 CNY (USD 151), respectively. The longer the protection duration, the higher the residents were willing to pay for HZ vaccine. WTP for domestic vaccine instead of imported vaccine was 126 CNY (USD 20). The residents were willing to pay for 103 CNY (USD 16) to get vaccination with a 1% risk of skin reaction instead of 20% risk of skin reaction. The higher the incidence of influenza-like symptoms, the less the residents were willing to pay for HZ vaccine. Compared with 2-dose vaccination schedules, residents were more willing to pay for 1-dose HZ vaccine.

Table 4 Residents’ WTP for different aspects of a vaccination program

	Monetary value (CNY)		
	Mean	95%CI	
Protection rate (Ref.=45%)			
60%	339.843	304.702	374.983
75%	620.937	572.224	669.650
90%	973.724	904.968	1042.479
Protection duration (Ref.=2 years)			
5 years	143.238	111.432	175.043
10 years	240.526	204.035	277.016
20 years	359.236	320.115	398.357
Number of vaccine doses (Ref.=1 dose)			
2 doses	-0.257	-21.092	20.579
Probability of influenza-like symptoms（Ref.=1%）			
5%	-57.323	-88.532	-26.113
10%	-59.001	-97.397	-20.604
20%	-96.595	-128.627	-64.563
Probability of skin reaction (Ref.=1%)			
5%	-54.534	-83.970	-25.098
10%	-82.658	-117.404	-47.912
20%	-103.322	-135.743	-70.902
Place of origin (Ref.= domestic)			
Imported	-125.687	-152.053	-99.320

3.4 Predicted uptake rates of HZ vaccination

The cost attribute was treated as a continuous variable and was mainly used to calculate the WTP. According to literature, we dropped the cost attribute from this analysis to show a more precise uptake rates of HZ vaccines to avoid the confusion of the hypothetical cost levels because levels of the cost attribute may not represent the real price of current or future HZ vaccination programs[28]. The base case is indicated as zero change in the probability of the X-axis and the data presented a change in uptake from the base case (Figure 2). The predicted uptake could be promoted the most by 20.84%, 14.46% and 7.72% if the protection rate was90%, 75% or 60% instead of a protection rate of 45% in the base case, respectively, holding all other attributes constant. Changes in other attributes and levels also had a relatively large impact on the expected uptake rate, especially when increasing the protection duration to 20 years or 10 years from 2 years in the base case or substituting the imported vaccines in the base case with domestic ones. The vaccination schedule could barely interfere with the uptake rate.

4. Discussion

Despite the increasing incidence of HZ and its clinical and economic burden on both patients and the society, there was no evidence to indicate Chinese residents' HZ vaccine preferences to promote vaccination uptake rate. In this DCE study of 2,864 residents on preferences for HZ vaccination in nine cities in China, we found that preferences among adults aged ≥ 25 years were affected by vaccination characteristics. Specifically, residents considered HZ vaccine effectiveness to be the most essential attribute, followed by protection duration. Cost had the mildest impact on residents' preferences and the number of doses did not seem to affect the preferences for HZ vaccination. We further explored how residents made a trade-off between monetary value and vaccine characteristics. Finally, we declared an explicit results about the probability of choosing different HZ vaccines.

Vaccine effectiveness, protection duration, probability of influenza-like symptoms, probability of skin reactions, place of origin and cost all showed to influence the residents' preferences for HZ vaccination. The residents preferred to select HZ vaccine with higher protection rate, longer protection duration, less side-effects and lower prices. This has been confirmed in several previous studies about preferences for HZ vaccination in the US[21], China[23] and other vaccines' acceptance[28, 34, 45]. Though The positive or negative signs of most of the coefficients in this study were consistent with our prior hypotheses and thus, showed theoretical validity[28]. Our study unexpectedly drew the same conclusions with a recent study about influenza vaccine preferences[43] that Chinese residents were more likely to select domestic vaccination. It is suggested that Chinese residents may have more confidence and trust in domestic vaccines nowadays, so the Chinese national immunization program shall recognize the importance of developing domestic vaccines[46]. Respondents slightly preferred vaccination schedules of 1 dose than 2 doses, despite the coefficient was not significant. Similar studies about HZ vaccine, hepatitis B vaccine and covid-19 vaccine all demonstrated that Chinese residents preferred shorter vaccination regimens[21, 34, 45], which could somehow prove the validity of our prior hypothesis.

We calculated the extension to which the residents preferred each attribute and levels. Among all seven attributes, effectiveness was the most important vaccine characteristic and protection duration was the next most important attribute. Specifically, increasing the protection rate from the lowest level to the highest level could yield 2.7 times as much as utilities increasing the same degree of protection duration of HZ vaccination. Though a recent study in the US declared that preferences for HZ vaccination were influenced the most by total cost and then vaccine effectiveness[21], studies about German travelers choosing travel vaccines[47] and girls in Netherlands choosing among HPV vaccinations[28] all showed that vaccine effectiveness was the most predominant attribute. Same results were derived from studies about preferences for covid-19 vaccination[33] and influenza vaccination[43] in China. Zhang et al[23] found that the most concerning HZ vaccine attribute for Chinese residents was 'vaccination of people surrounding them', however, this attribute was not included in our study. After excluding attributes not presented in our study, vaccine efficacy remained the most significant attribute

identified in most researches[23, 28, 33, 43, 47]. In the present study, place of origin, influenza-like symptoms, dermal reactions and cost associated with HZ vaccination were of lesser importance and the least important characteristic was the number of vaccine doses, which were highly consistent with another study about HZ vaccine preferences[21]. Consequently, promoting the effectiveness and protection duration while reducing side-effects is a practical way to increase HZ vaccine uptake.

We found that the residents were willing to pay the most to alter HZ vaccine of 45% effectiveness to 75% effectiveness and 90% effectiveness with 621 CNY (USD 96) and 974 CNY (USD 151), respectively, followed by spending 359 CNY (USD 56) to exchange HZ vaccine with 2 years protection duration to a protection duration of 20 years, again showing the importance of vaccine effectiveness and protection duration. Otherwise, the residents were willing to pay 103 CNY (USD 16) to get vaccination with a 1% risk of skin reaction instead of 20% risk of skin reaction. The trend of changing in WTP was similar to the trend in previous studies[23, 30, 34], which reminded the policy-makers to have an awareness of how to price the HZ vaccines with different attribute levels. Hypothetically, if there were an imported HZ vaccine of 45% effectiveness, 2 years of protection and 20% probability of side-effects (a combination of the reference levels), it may be acceptable to pay 1658 CNY (USD 257) more for domestic HZ vaccines of an effectiveness of 90%, 20 years of protection and 1% probability of both influenza-like symptoms and skin reactions. An advantage of using DCE is to measure WTP indirectly rather than to obtain WTP by asking relevant questions directly[28, 30]. Despite there is evidence to suggest that the inclusion and levels of the cost attribute could influence the estimates[40], we found no evidence proving that including a cost attribute could cause changes in vaccine preferences[48].

Several limitations should be considered when interpreting our results. First, though we selected the most relevant attributes based on literature, we were unable to cover all aspects of vaccination services. For instance, we did not include location of vaccination as an estimated attribute as many studies did[21, 34], but our investigation took place in community health centers with the respondents lived nearby and would probably get vaccinated in their community, saving us from asking the place of vaccination. Second, since this study surveyed residents in urban area, which precludes generalization of the findings [49]. Despite this, a direct policy implication is the improvement of vaccine effectiveness will increase the uptake of HZ vaccination in urban China. Third, our sample contained a relatively large number of eastern region, female and married residents. Preference heterogeneity among Chinese residents requires future investigation.

There are also some notable strengths. To our knowledge, this is the first study to investigate the preferences for HZ vaccination comprehensively in China. Our findings verified that the uptake rate of HZ vaccine can be explained by complex vaccination attributes, particularly vaccine effectiveness. We provide new information about WTP by evaluating the trade-off between monetary value and HZ vaccine attributes to help price the vaccination programs. Additionally, it is novel that we focused on adults over 25 years old instead of 50 years old, which largely expanded the study population

and made it possible to generalize the results to younger generation.

5. Conclusions

In summary, we used DCE to illustrate that Chinese urban adults made trade-offs between HZ vaccination attributes, and effectiveness was the most important characteristic. The residents had the highest WTP to enhance the effectiveness of vaccines, demonstrating the significance of promoting vaccine effectiveness. We also presented the probability of choosing different HZ vaccines to give suggestions to policy-makers on developing and pricing the HZ vaccination programs.

Contributors

YX: investigation, formal analysis, writing-original draft, and writing-review&editing; MW: conceptualization, data curation, investigation, writing-original draft; MH, YW and BY: investigation, writing-review&editing; DZ and PH: conceptualization, data curation, and project administration. All authors reviewed and approved the final manuscript.

Declaration of interests

We declare no competing interests.

Acknowledgments

We would like to thank all those who participated in this project.

Data availability

Anonymized individual-level data and datasets generated or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Parikh R, Widenmaier R, Lecrenier N. A practitioner's guide to the recombinant zoster vaccine: review of national vaccination recommendations. Expert Review of Vaccines. 2021; 20:1065-75.
2. Cunningham AL, Lal H, Kovac M, Chlibek R, Hwang SJ, Diez-Domingo J, et al. Efficacy of the Herpes Zoster Subunit Vaccine in Adults 70 Years of Age or Older. New England Journal of Medicine. 2016; 375:1019-32.
3. Gilden D, Nagel MA, Cohrs RJ, Mahalingam R. The Variegate Neurological Manifestations of Varicella Zoster Virus Infection. Current Neurology and Neuroscience Reports. 2013; 13.
4. Li Y, An ZJ, Yin DP, Liu YM, Huang ZY, Xu JF, et al. Disease Burden Due to Herpes Zoster among Population Aged >= 50 Years Old in China: A Community Based Retrospective Survey. Plos One. 2016; 11.
5. Kawai K, Gebremeskel BG, Acosta CJ. Systematic review of incidence and complications of herpes zoster: towards a global perspective. Bmj Open. 2014; 4.
6. Bricout H, Haugh M, Olatunde O, Prieto RG. Herpes zoster-associated mortality in Europe: a systematic review. Bmc Public Health. 2015; 15.
7. Lal H, Cunningham AL, Godeaux O, Chlibek R, Diez-Domingo J, Hwang SJ, et al. Efficacy of an Adjuvanted Herpes Zoster Subunit Vaccine in Older Adults. New England Journal of Medicine. 2015; 372:2087-96.
8. Jiang B, Wang Q, Wang Z, Xu Y, Yang T, Yang W, et al. Willingness to accept herpes zoster vaccines and the influencing factors in China. BMC infectious diseases. 2022; 22:888.
9. Harvey M, Prosser LA, Rose AM, Ortega-Sanchez IR, Harpaz R. Aggregate health and economic burden of herpes zoster in the United States: illustrative example of a pain condition. Pain. 2020; 161:361-8.
10. Li Z-W, Yin C-N, Wang H-T, Du W-Y, Wang W-J, Xue F-Z, et al. Incidence trend and disease burden of seven vaccine-preventable diseases in Shandong province, China, 2013–2017: Findings from a population-based observational study. Vaccine: X. 2022; 10:100145.
11. Sun XH, Wei Z, Lin HB, Jit M, Li ZW, Fu CX. Incidence and disease burden of herpes zoster in the population aged >= 50 years in China: Data from an integrated health care network. Journal of Infection. 2021; 82:253-60.
12. Amirthalingam G, Andrews N, Keel P, Mullett D, Correa A, de Lusignan S, et al. Evaluation of the effect of the herpes zoster vaccination programme 3 years after its introduction in England: a population-based study. Lancet Public Health. 2018; 3:E82-E90.
13. Koshy E, Mengting L, Kumar H, Jianbo W. Epidemiology, treatment and prevention of herpes zoster: A comprehensive review. Indian journal of dermatology, venereology and leprology. 2018; 84:251-62.
14. Chiyaka ET, Nghiem VT, Zhang L, Deshpande A, Mullen PD, Le P. Cost-Effectiveness of Herpes Zoster Vaccination: A Systematic Review. Pharmacoeconomics. 2019; 37:169-200.
15. Wang Q, Yang L, Li L, Liu C, Jin H, Lin L. Willingness to Vaccinate Against Herpes Zoster and Its Associated Factors Across WHO Regions: Global Systematic Review and Meta-Analysis. JMIR public health and surveillance. 2023; 9:e43893.
16. Spencer-Cotton A. Applied Choice Analysis, 2nd edition. Australian Journal of Agricultural and Resource Economics. 2016; 60:E17-E8.
17. Brown KF, Kroll JS, Hudson MJ, Ramsay M, Green J, Long SJ, et al. Factors underlying parental decisions about combination childhood vaccinations including MMR: A systematic review. Vaccine. 2010; 28:4235-48.
18. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. Eclinicalmedicine. 2020; 26.
19. Diks ME, Hiligsmann M, van der Putten IM. Vaccine preferences driving vaccine-decision making of different target groups: a systematic review of choice-based experiments. BMC infectious diseases. 2021; 21:879.
20. Damm O, Witte J, Greiner W. A SYSTEMATIC REVIEW OF HERPES ZOSTER VACCINE ACCEPTANCE. Value in Health. 2015; 18:A592-A.
21. Patterson BJ, Myers K, Stewart A, Mange B, Hillson EM, Poulos C. Preferences for herpes zoster vaccination among adults aged 50 years and older in the United States: results from a discrete choice experiment. Expert Review of Vaccines. 2021; 20:729-41.
22. Eilers R, de Melker HE, Veldwijk J, Krabbe PFM. Vaccine preferences and acceptance of older adults. Vaccine. 2017; 35:2823-30.
23. Zhang H, Zhang LR, Chu LC, Sun X, Jiang XW. Factors influencing herpes zoster vaccination among older people in China: results from a discrete choice experiment. Public Health. 2023; 220:33-4.
24. Dong D, Xu RH, Wong EL, Hung CT, Feng D, Feng Z, et al. Public preference for COVID-19 vaccines in China: A discrete choice experiment. Health expectations : an international journal of public participation in health care and health policy. 2020; 23:1543-78.
25. Lavelle TA, Messonnier M, Stokley S, Kim D, Ramakrishnan A, Gebremariam A, et al. Use of a choice survey to identify adult, adolescent and parent preferences for vaccination in the United States. Journal of Patient-Reported Outcomes. 2019; 3.

26. de Bekker-Grob EW, Swait JD, Kassahun HT, Bliemer MCJ, Jonker MF, Veldwijk J, et al. Are Healthcare Choices Predictable? The Impact of Discrete Choice Experiment Designs and Models. Value in Health. 2019; 22:1050-62.
27. Bekker-Grob EW, Donkers B, Bliemer MCJ, Veldwijk J, Swait JD. Can healthcare choice be predicted using stated preference data? Social Science & Medicine. 2020; 246.
28. de Bekker-Grob EW, Hofman R, Donkers B, van Ballegooijen M, Helmerhorst TJ, Raat H, et al. Girls' preferences for HPV vaccination: a discrete choice experiment. Vaccine. 2010; 28:6692-7.
29. Ryan M. Discrete choice experiments in health care. Bmj. 2004; 328:360-1.
30. Sadique MZ, Devlin N, Edmunds WJ, Parkin D. The Effect of Perceived Risks on the Demand for Vaccination: Results from a Discrete Choice Experiment. Plos One. 2013; 8.
31. Jiang MZ, Fu Q, Xiong JY, Li XL, Jia EP, Peng YY, et al. Preferences heterogeneity of health care utilization of community residents in China: a stated preference discrete choice experiment. BMC health services research. 2020; 20:430.
32. Bridges JFP, Hauber AB, Marshall D, Lloyd A, Prosser LA, Regier DA, et al. Conjoint Analysis Applications in Health-a Checklist: A Report of the ISPOR Good Research Practices for Conjoint Analysis Task Force. Value in Health. 2011; 14:403-13.
33. Leng A, Maitland E, Wang S, Nicholas S, Liu R, Wang J. Individual preferences for COVID-19 vaccination in China. Vaccine. 2021; 39:247-54.
34. Guo N, Zhang G, Zhu D, Wang J, Shi L. The effects of convenience and quality on the demand for vaccination: Results from a discrete choice experiment. Vaccine. 2017; 35:2848-54.
35. Mangham LJ, Hanson K, McPake B. How to do (or not to do) ... Designing a discrete choice experiment for application in a low-income country. Health Policy Plan. 2009; 24:151-8.
36. Zhu D, Shi X, Nicholas S, Ye X, Chen S, He P. Preferences for Hearing Aid Attributes Among People with Moderate or Greater Hearing Loss in Rural China: A Discrete Choice Experiment. Patient preference and adherence. 2020; 14:643-52.
37. Viney R, Savage E, Louviere J. Empirical investigation of experimental design properties of discrete choice experiments in health care. Health Economics. 2005; 14:349-62.
38. Hensher DA, Rose JM, Greene WH. Applied Choice Analysis: A Primer. Cambridge: Cambridge University Press; 2005.
39. Lancsar E, Savage E. Deriving welfare measures from discrete choice experiments: inconsistency between current methods and random utility and welfare theory. Health Economics. 2004; 13:901-7.
40. Ratcliffe J. Use of conjoint analysis to elicit willingness-to-pay values - Proceed with caution? International Journal of Technology Assessment in Health Care. 2000; 16:270-5.
41. Orme BJSSSTP. Sample size issues for conjoint analysis studies. 1998.
42. McFadden D, Train K. Mixed MNL models for discrete response. Journal of Applied Econometrics. 2000; 15:447-70.
43. Li SP, Gong TT, Chen G, Liu P, Lai XZ, Rong HG, et al. Parental preference for influenza vaccine for children in China: a discrete choice experiment. Bmj Open. 2022; 12.
44. de Bekker-Grob EW, Rose JM, Bliemer MC. A closer look at decision and analyst error by including nonlinearities in discrete choice models: implications on willingness-to-pay estimates derived from discrete choice data in healthcare. Pharmacoeconomics. 2013; 31:1169-83.
45. Verelst F, Willem L, Kessels R, Beutels P. Individual decisions to vaccinate one's child or oneself: A discrete choice experiment rejecting free-riding motives. Social Science & Medicine. 2018; 207:106-16.
46. Yigit M, Ozkaya-Parlakay A, Senel E. Evaluation of COVID-19 Vaccine Refusal in Parents. Pediatric Infectious Disease Journal. 2021; 40:E134-E6.
47. Poulos C, Curran D, Anastassopoulou A, De Moerlooze L. German travelers' preferences for travel vaccines assessed by a discrete choice experiment. Vaccine. 2018; 36:969-78.
48. Essers BAB, van Helvoort-Postulart D, Prins MH, Neumann M, Dirksen CD. Does the Inclusion of a Cost Attribute Result in Different Preferences for the Surgical Treatment of Primary Basal Cell Carcinoma? A Comparison of Two Discrete-Choice Experiments. Pharmacoeconomics. 2010; 28:507-20.
49. Lv M, Shen Y, Li W, Wu J, Wen X, Zhu D, et al. Preferences of general practitioners for delivering adult vaccination: A discrete choice experiment. Human Vaccines & Immunotherapeutics. 2023.

Supplementary Files

Untitled.
URL: http://asset.jmir.pub/assets/bc68f7f2c8d61518413d0278cacddfb4.docx

Figures

Notes: There are four versions of the DCE questions, each with eight questions, and each respondent is randomly assigned a version of the questions.

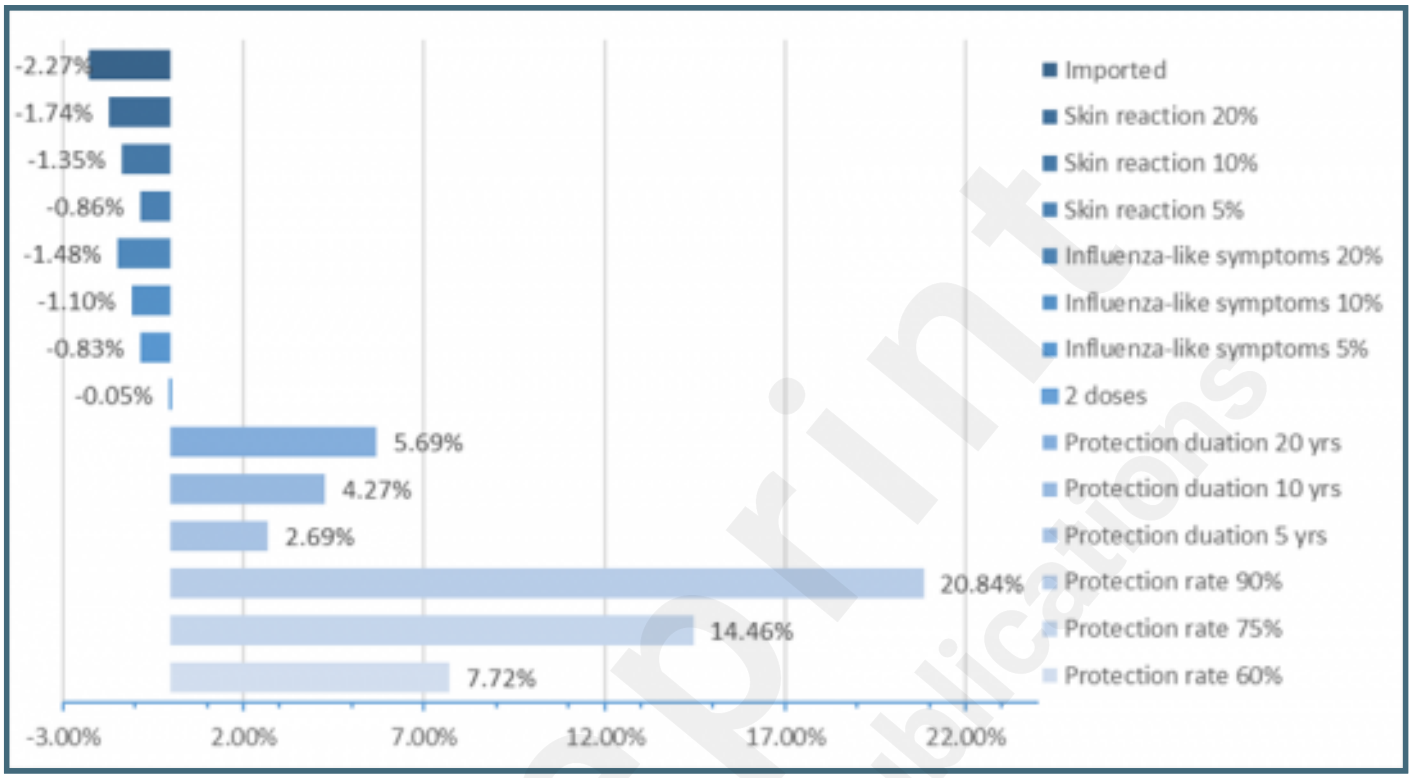
Thank you for agreeing to take part in this survey.

Assuming that you have two options for herpes zoster vaccine that differ in price, effectiveness, protection duration, adverse effects, etc., please choose the vaccination option you prefer based on your personal preference among the pairs of options below.When you make a choice, please assume that all conditions are the same for choice 1 and choice 2 except for the factors listed.

	Vaccine 1	Vaccine 2
Effectiveness	90%	45%
Protection Duration(years)	2	5
Number of vaccine doses	2 doses (2 months apart)	1 dose
Probability of influenza-like symptoms	1%	5%
Probability of skin reaction	20%	1%
Place of origin	Imported	Domestic
Price(CNY)	0	400

Which do you prefer: (1) Vaccine 1; (2) Vaccine 2; (3) Neither

Notes: (1) The base case is HZ vaccination at 45% protection rate, protection duration of 2 years, vaccination schedule of 1 dose, 1% risk of influenza-like symptoms, 1% risk of skin reaction and domestic place of origin; (2) The base case is indicated as zero change in the probability of the X-axis; (3) Yrs is short for years.



Multimedia Appendixes

Untitled.
URL: http://asset.jmir.pub/assets/444beddda90c7e67d1853aa689ad816a.docx

Untitled.
URL: http://asset.jmir.pub/assets/37b1b06b30b633c00d46a5db8ecbc88d.docx