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Factors associated with the uptake of seasonal influenza vaccination in the general population: a large, population-based survey in Beijing, China

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ABSTRACT

Objectives

Vaccination is the best option to reduce the mortality and morbidity of influenza. To optimize the influenza vaccination coverage rates, the status of coverage rates and their factors need to be understood. In this study, we aimed to estimate the coverage rate in the 2014-2015 season and identify its determinants in the general population in Beijing, China.

Methods

The survey was conducted among the general population using a self-administered, anonymous questionnaire from May to June, 2015. The main outcome was the vaccination rate of influenza vaccine. Weighted analysis was conducted to calculate the vaccination coverage rates. Multivariate logistic regression models were performed to identify the factors associated with uptake of the vaccine.

Results

A total of 7106 participants completed the survey. The coverage rate was 20.6% in the 2014-2015 influenza season. The variables that were significantly associated with the uptake of vaccination were being older adults (OR 3.222; 95% CI 2.747-3.778), lower education (OR 1.839; 95% CI 1.497-2.259), living in urban areas (OR 1.308; 95% CI 1.122-1.525), lower monthly income (OR 0.835; 95% CI 0.706-0.988), having medical insurance (OR 2.23; 95% CI 1.522-3.267), having a chronic illness (OR 1.520; 95% CI 1.318-1.753), having a fever in the past year (OR 1.36; 95% CI 1.13-1.638), active recommendation from healthcare workers (OR 4.511; 95% CI 3.818-5.331), perceived susceptibility to disease (OR 1.192; 95% CI 1.031-1.377), perceived effectiveness of vaccination (OR 1.8; 95% CI 1.47-2.204), perceived side effects of vaccination (OR 0.707; 95% CI 0.613-0.814) and awareness of free influenza vaccine policy in Beijing (OR 1.298; 95% CI 1.031-1.634).

Conclusions

The influenza vaccination coverage rate was relatively low in Beijing, China. Perceptions towards influenza and its vaccine were significantly associated with the uptake of influenza vaccine. Health education programs targeted at increasing public perceptions are needed to improve the vaccination coverage rates.

Key words

Influenza vaccine, Vaccination, Coverage, Factors, Adult

Strengths and limitations of this study:

Strengths of this study are the large sample size of 7206 participants and the high response rate of 98.7%, indicating that the findings are very representative and reliable.

This study analyse most of the influencing factors associated with uptake of the influenza vaccine (eg, socio-economic factors, perceptions and impact of healthcare workers, etc).

The findings of this study inform seasonal influenza vaccine policy in China, a country where vaccination coverage among most groups is very low.

The main limitation is self-reported influenza vaccination uptake, which could result in possible recall bias.

INTRODUCTION

Seasonal influenza is a serious public health problem that causes substantial mortality and morbidity especially in the elderly and people with high risk conditions [1]. Worldwide, annual epidemics are estimated to result in about 3 to 5 million cases of severe illness and 250 000 to 500 000 deaths [2]. Influenza vaccination is the effective way to minimize the mortality and morbidity related to influenza [3-5]. Many public health organizations including China Centers for Disease Prevention and Control have recommended all people over the age of six months particularly these at high risk to get the influenza vaccine yearly [6]. However, promoting the willingness to uptake influenza vaccine can be a difficult challenge for local governments [7]. To optimize the vaccination coverage rates, the status of coverage rates and their factors need to be understood. To date, most studies on influenza vaccination coverage focused on special subpopulations such as the elderly, healthcare workers, and other high-risk persons, but few population-based surveys were conducted among the general population [8-9].

Beijing is the capital of China with a population of about 20 millions. Convenient transportation and high population density make Beijing easy to be threatened by epidemics of both seasonal and pandemic influenza [10]. Since 2007, the Beijing Government has provided the free influenza vaccines to people aged 60 or above and the students from primary or middle schools between September and November each year. Our pervious study in Beijing estimated the coverage rate of the general population to be 16.7% in 2008/2009, 16.9% in 2010/2011 and 21.8% during the 2009 pandemic, and the rates were much lower than that of Western countries [11]. In this previous study, we only determined the demographics factors of influenza vaccination uptake, but didn't analyze the other important factors including perceptions of personal risk, disease severity, effectiveness and side effects of vaccination and impact of healthcare workers [11].

In this study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in the general population of Beijing. We aimed to estimate the coverage rates in the 2014-2015 influenza season and compare the rates with our previous study. In addition, we sought to identify the factors associated with uptake of the vaccine, and included demographics factors, perceptions towards influenza and its vaccine, and impact of healthcare workers in the data analysis.

METHODS

Study participants

This study was a population-based survey in Beijing, China. The target population was Chinese adult who was aged ≥ 18 years and had lived in Beijing for more than half a year. The function $n=\mu_\alpha^2\times\pi\times(1-\pi)/\delta^2\times deff$ was used to calculate the simple size of each subgroup. We estimated a simple size of 576 participants per subgroup, based on $\mu_\alpha=1.96$, the influenza vaccination rate (π) =50%, maximum permissible error (δ) =0.1π, and the design effect of complex sampling (deff) = 1.5. Considering residence (urban or suburban), and different age groups (18–29, 30–39, 40–49, 50–59 and ≥60), and a no-answer rate of 25%, the optimal sample size for the present study was 7200 (576 participants per subgroup×10 subgroups×1.25). Participants were randomly selected from the 150 survey locations which were the same as that of the previous study [11]. To meet the sample size requirement, all adults in each survey location were numbered and then 48 of them were selected at random.

Data collection

The survey was conducted using a self-administered, anonymous questionnaire from May to June, 2015. The questionnaire was available in Chinese and consisted of five sections: history of receiving seasonal influenza vaccine in 2014-2015, history of having a fever in the past year, experience of recommendation by healthcare workers, perceptions towards influenza and its vaccine and demographics information. (1) The history of receiving seasonal influenza vaccine

was assessed by asking: "Have you received seasonal influenza vaccine during the last season (2014-2015)?" with the response option of "yes" or "no". (2) Active recommendation from healthcare workers was assessed by asking: "Did healthcare workers recommend seasonal influenza vaccine to you during the last season (2014-2015)?" with the response option of "yes" or "no". (3) The history of having a fever in the past year was assessed by asking: "Have you ever had a fever in the past year?" with the response option of "yes" or "no". (4) To assess perceptions towards influenza and its vaccine, we asked the following yes/no questions: "Do you think influenza is a serious disease?", "Do you think you are afraid of catching influenza during an epidemic?", "Do you think vaccine can prevent influenza infections?", "Are you scared of vaccine side effects?", "Do you know the free influenza vaccine policy in Beijing?". (5) To collect information of demographics characteristics, participants were asked to report their sex (female or male), age (continuous), education attainment (primary school or illiterate, junior high school, senior high school, 3 year college graduate or above), residence (urban or suburban), monthly income per capita (0-2000, 2000-5000, >5000 yuans), medical insurance (yes or no), family population (continuous), number of children within the family (continuous) and history of having a chronic illness (yes or no). All the questions were developed based on measures adapted from our previous study and the existing literatures [11-12].

All interviews were undertaken by local healthcare workers. Before each questionnaire was distributed, all investigators were required to explain the purpose, procedure and confidentiality agreement of this study to respondents, and written informed consents were obtained from them. In most case, the participants completed the questionnaires by themselves. For the participants who could not understand the questionnaires, the investigators would read and explain the questionnaires to them.

Ethics Statement

This study was approved by the Institutional Review Board and Human Research Ethics Committee of Beijing Center for Disease Prevention and Control. Anonymity of the participants was guaranteed to participants, and informed consent from participants was required during the surveys.

Statistical analysis

The main outcome was the vaccination rate of influenza vaccine in the 2014-2015 influenza season. Descriptive analyses were performed to generate frequency distributions of the survey variables, and differences between the subgroups were tested by Pearson's Chi-square test. The numbers of partcipants reporting missing data were listed in the tables. Weighted analysis was conducted to calculate the age, sex, and residence-specific vaccination rates, accounting for the age, sex, and residence of Beijing population, as reported in the 2010 Census of Beijing [13]. Multivariate logistic regression models were then performed to examine the factors associated with uptake of the vaccine, and odd ratios (OR) and their 95% confidence intervals (95% CI) were used as measures of association. All the statistical tests were two-sided, with a p value <0.05 considered to be statistically significant. Data entry was performed using Epidata software Version 3.1. Data analyses were carried out using SPSS Version 20.0 (SPSS Inc, Chicago, IL).

RESULTS

Demographic characteristics

Table 1 shows demographic characteristics of study participants. Of the 7200 subjects approached, 7106 participants completed the survey. Of them, approximately half were female (n=3614, 50.9%) and lived in urban areas (n=3468, 48.8%). The distribution of age was as follows: 18-29: 20.5% (n=1450), 30-39: 20.1% (n=1424), 40-49: 20.6% (n=1461), 50-59: 19.6% (n=1391), ≥ 60 years: 19.2% (n=1362). Most of participants (n=6601, 94.0%) had medical insurance. Almost all participants (n=6710, 95.7%) had no or one child in their family. Only one tenth (n=730, 10.3%) of participants reported a low education level (illiterate or primary school). Three out of ten (n=2149, 30.2%) participants reported having a chronic illness, and one eighth (n=894, 12.6%) had a fever in the past year. Approximately three fifths (n=4168, 58.7%) reported that they had got active recommendation from healthcare workers.

Influenza vaccination rates by demographic characteristics

Table 1 shows the vaccination rates of influenza vaccine by demographic characteristics. Overall, 1610 (22.7%) participants reported that they had received seasonal influenza vaccine during the last season (2014-2015). The rates didn't differ by sex and residence (P>0.05). The rate was 49.3% among older adults aged ≥60, significantly higher than younger people (P<0.05). The rates decreased with the increasing education levels, from 43.8% of illiterate participants or those with the education of primary school to 18.7% of those with 3-year college graduate or higher (P<0.05). The significantly different rates were observed across the three categories of income (P<0.05), with 27%, 20.7% and 21.8% of participants whose monthly income per capita were 0-2000, 2000-5000 and >5000 yuans respectively. The rates among participants having medical insurance were more likely to be vaccinated (23.4% vs. 9.5%, P<0.05). The rates decreased with the family size, from 28.7% of participants whose family size were 1-2 to 21.5% of those whose family size were ≥6 (P<0.05). The rates were significantly higher among people having chronic illness (35.5% vs. 17.1%, P<0.05) or having a fever in the past year (27.5% vs. 22%, P<0.05). Participants who had got active recommendation from healthcare workers were more likely to be vaccinated (33% vs. 8%, P<0.05).

Table 1 Demographic characteristic of participants and the vaccination rates of influenza vaccine by demographic characteristics during the 2014-2015 influenza season

Factors		Participants		Participants who had received seasonal influenza vaccine			
		No. of subjects	%	No. of subjects	%	Chi-square value	P value
Sex							
	Male	3484	49.1	778	22.3	0.4	0.541
	Female	3614	50.9	829	22.9		
	Missing	8		3			
Age (years)							
	18-29	1450	20.5	216	14.9	717.2	<0.001
	30-39	1424	20.1	212	14.9		
	40-49	1461	20.6	203	13.9		
	50-59	1391	19.6	302	21.7		
	≥60	1362	19.2	672	49.3		
	Missing	18		5			
Highest education							
	primary school or illiterate	730	10.3	320	43.8	220.7	<0.001
	junior high school	1850	26.1	418	22.6		
	senior high school	2167	30.6	422	19.5		
	3 year college graduate or above	2334	33	437	18.7		
	Missing	25		13			
Residence							
	Suburban	3638	51.2	805	22.1	1.2	0.275
	Urban	3468	48.8	805	23.2		
	Missing	0		0			
Monthly income per capita (yuans)							
	0-2000	1887	27.3	509	27	28.5	<0.001
	2000-5000	3434	49.7	710	20.7		
	>5000	1589	23	346	21.8		
	Missing	196		45			
Having medical insurance							
	No	422	6	40	9.5	44.1	<0.001

	Yes	6601	94	1546	23.4		
	Missing	83		24			
Family population							
	1-2	547	7.7	157	28.7	47.3	<0.001
	3	1831	25.8	487	26.6		
	4	2415	34	458	19		
	5	1179	16.6	264	22.4		
	≥6	1130	15.9	243	21.5		
	Missing	4		1			
Number of children in the family							
	0	3915	55.8	959	24.5	22.4	<0.001
	1	2795	39.9	548	19.6		
	≥2	300	4.3	65	21.7		
	Missing	96		38			
History of having a chronic illness							
	Yes	2149	30.2	763	35.5	290.2	<0.001
	No	4957	69.8	847	17.1		
	Missing	0		0			
History of having a fever in the past year							
	Yes	894	12.6	246	27.5	13.5	<0.001
	No	6194	87.4	1363	22		
	Missing	18		1			
Recommendation from healthcare workers							
	Yes	4168	58.7	1376	33	617.0	<0.001
	No	2938	41.3	234	8		
	Missing	0		0			
Overall		7106	100	1610	22.7		

Note: Missing referred to "how many people did not answer this question".

Weighted vaccination coverage rates of influenza vaccine during season 2008/2009, 2009/2010, 2010/2011 and 2014/2015

Table 2 shows the weighted coverage rates of influenza vaccine during season 2008/2009, 2009/2010, 2010/2011 and 2014/2015. The coverage rate in the 2014-2015 influenza season was comparable to that in season 2009/2010 (20.6% vs. 21.8%, P>0.05), but higher than that in season 2008/2009 and 2010/2011 (20.6% vs. 16.9% and 16.7%, P<0.05). Considering the difference between the age groups, the rate was 48.7% for older adults and 14%-22.1% for other age groups during season 2014/2015, and the difference was also observed in other three seasons.

Table 2 Weighted vaccination coverage rates of influenza vaccine during season 2008/2009, 2009/2010, 2010/2011 and 2014/2015

Factors		Season 2008/2009 Weighted %(95 % CI)	Season 2009/2010 Weighted %(95 % CI)	Season 2010/2011 Weighted %(95 % CI)	Season 2014/2015 Weighted %(95 % CI)
Sex					
	Male	16.3(15.3-17.2)	21.3(20.2-22.3)	16(15–16.9)	19.6(18.3-20.9)
	Female	17.6(16.7-18.5)	22.3(21.3-23.3)	17.5(16.5-18.4)	21.7(20.4-23)
Age (years)					
	18-29	13.7(12.4-15)	18.7(17.2-20.1)	12.3(11–13.5)	14.9(13.1-16.7)
	30-39	13(11.7-14.3)	16(14.6-17.4)	11.4(10.2-12.6)	15.2(13.3-17.1)
	40-49	13.3(12–14.6)	17.2(15.6-18.6)	11.6(10.4-12.8)	14(12.2-15.8)

	50-59	15.3(13.9-16.6)	19.5(18–21)	14.9(13.6-16.2)	22.1(19.9-24.3)
	≥60	36.3(34.5-38.2)	46 (44.1-48)	43.1(41.1-45)	48.7(46-51.4)
Residence					
	Suburban	15.6(14.7-16.5)	21.5(22.3-24.3)	16.8(15.9-17.8)	19.7(18.4-21)
	Urban	17.7(16.7-18.7)	22 (21–23)	16.6(15.7-17.6)	21.2(19.8-22.6)
Overall		16.9(16.2-17.5)	21.8(21.1-22.5)	16.7(16.1-17.4)	20.6(19.7-21.5)

Note: The rates of season 2008/2009, 2009/2010 and 2010/2011 were extracted from our previous study [11]. Weighted analysis was conducted to calculate the age, sex, and residence-specific vaccination rates, accounting for the age, sex, and residence of Beijing population. 95% CI=95% confidence intervals.

Perceptions of participants by ages

Table 3 shows the perceptions of participants by ages. Regarding perceptions of all adults, 5793 (81.5%) reported "influenza vaccine can prevent infections" and 5958 (83.8%) reported "awareness of free influenza vaccine policy in Beijing". Approximately three fifths of participants reported "I am afraid of catching influenza during an epidemic" (n=4320) and "I am afraid of side effects" (n=4273). Only half of them reported "Influenza is a serious disease" (n=3720). Pearson's Chi-square tests indicated that older adults had better perceptions of severity of disease, side effects and awareness of free influenza vaccine policy in Beijing; and older adults were more likely to get acitve recommendation from healthcare workers and have a history of having chronic illness (P<0.05).

Table 3 Perceptions, recommendation from healthcare workers and disease history of participants by ages during the 2014-2015 influenza season

Factors		All adults		Age=18-59 years		Age≥60 years		Chi-square value	P value
		No. of subjects	%	No. of subjects	%	No. of subjects	%		
Perceived severity of disease (influenza is a serious disease)									
	Yes	3702	52.1	2934	51.2	762	55.9	9.77	0.002
	No	3404	47.9	2792	48.8	600	44.1		
	Missing	0		0		0			
Perceived susceptibility to disease (I am afraid of catching influenza during an epidemic)									
	Yes	4320	60.8	3469	60.6	839	61.6	0.478	0.489
	No	2786	39.2	2257	39.4	523	38.4		
	Missing	0		0		0			
Perceived effectiveness of vaccination (influenza vaccine can prevent infections)									
	Yes	5793	81.5	4656	81.3	1125	82.6	1.21	0.271
	No	1313	18.5	1070	18.7	237	17.4		
	Missing	0		0		0			
Perceived side effects of vaccination (I am afraid of side effects)									
	Yes	4273	60.1	3525	61.6	736	54	25.972	<0.001

	No	2833	39.9	2201	38.4	626	46		
	Missing	0		0		0			
Awareness of free influenza vaccine policy in Beijing									
	Yes	5958	83.8	4755	83	1186	87.1	13.211	<0.001
	No	1148	16.2	971	17	176	12.9		
	Missing	0		0		0			
Recommendation from healthcare workers									
	Yes	4168	58.7	3160	55.2	996	73.1	146	<0.001
	No	2938	41.3	2566	44.8	366	55.2		
	Missing	0		0		0			
History of having a fever in the past year									
	Yes	894	12.6	702	12.3	188	13.8	2.408	0.121
	No	6194	87.4	5010	87.7	1170	86.2		
	Missing	18		14		4			
History of having chronic illness									
	No	4957	69.8	1239	21.6	902	66.2	103.8	<0.001
	Yes	2149	30.2	4487	78.4	460	33.8		
	Missing	0		0		0			

Note: Missing referred to "how many people did not answer this question". Because there were eighteen participants who did not answer the question of age, the sum number of the two age groups was not equal to the simple size of all adults.

Multiple logistic regression analysis for the factors associated with the influenza vaccination rates

As shown in Table 4, after adjustment for potential confounding variables, the variables that were significantly associated with a higher influenza vaccination rate were being older adults aged ≥60 years (OR 3.222; 95% CI 2.747-3.778), lower education (OR 1.839; 95% CI 1.497-2.259), living in urban areas (OR 1.308; 95% CI 1.122-1.525), having medical insurance (OR 2.23; 95% CI 1.522-3.267), having a chronic illness (OR 1.52; 95% CI 1.318-1.753), having a fever in the past year (OR 1.36; 95% CI 1.13-1.638), active recommendation from healthcare workers (OR 4.511; 95% CI 3.818-5.331), perceived susceptibility to disease (OR 1.192; 95% CI 1.031-1.377), perceived effectiveness of vaccination (OR 1.8; 95% CI 1.47-2.204), and awareness of free influenza vaccine policy in Beijing (OR 1.298; 95% CI 1.031-1.634). Meanwhile, lower monthly income (OR 0.835; 95% CI 0.706-0.988) and perceived side effects of vaccination (OR 0.707; 95% CI 0.613-0.814) were significantly associated with a lower rate of influenza vaccination.

Table 4 Multiple logistic regression analysis for the factors associated with the influenza vaccination rates during the 2014-2015 influenza season

Factors		OR	95% CI for OR		P value
Age (years)					
	≥60	3.222	2.747	3.778	<0.001
	18-60	1			
Highest education					
	primary school or illiterate	1.839	1.497	2.259	<0.001
	junior high school or	1			

	above				
Residence					
	Urban	1.308	1.122	1.525	0.001
	Suburban	1			
Monthly income per capita (yuans)					0.07
	0-2000	0.94	0.761	1.161	0.565
	2000-5000	0.835	0.706	0.988	0.036
	>5000	1			
Having medical insurance					
	Yes	2.23	1.522	3.267	<0.001
	No	1			
History of having a chronic illness					
	Yes	1.52	1.318	1.753	<0.001
	No	1			
History of having a fever in the past year					
	Yes	1.36	1.13	1.638	0.001
	No	1			
Recommendation from healthcare workers					
	Yes	4.511	3.818	5.331	<0.001
	No	1			
Perceived susceptibility to disease (I am afraid of catching influenza during an epidemic)					
	Yes	1.192	1.031	1.377	0.018
	No	1			
Perceived effectiveness of vaccination (Influenza vaccine can prevent infections)					
	Yes	1.8	1.47	2.204	<0.001
	No	1			
Perceived side effects of vaccination (I am afraid of side effects)					
	Yes	0.707	0.613	0.814	<0.001
	No	1			
Awareness of free influenza vaccine policy in Beijing					
	Yes	1.298	1.031	1.634	0.027
	No	1			

Note: OR= odd ratios; 95% CI=95% confidence intervals.

DISCUSSION

In this study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in the general population of Beijing. Our survey showed that vaccination coverage rates in the general population of Beijing was 20.6% during season 2014/2015, which

was nearly to European countries [9] (25.0% in UK, 27.4% in Germany, 21.8% in Spain, 24.2% in France, and 24.4% in Italy) but much lower than US [14] (39.7% in 2014/2015). Compared to season 2008/2009 and 2010/2011 [11], an increase in vaccination coverage was observed during season 2014/2015 in Beijing. Since 2007, the free influenza vaccines have been provided to the elderly and the students from primary and middle school in Beijing. Meanwhile, annual influenza immunization campaigns are conducted each year. The immunization activities including health education or promotion and better access to vaccine might increase the coverage of influenza vaccine in Beijing [15].

The present study showed that older adults were more likely to be vaccinated than younger adults. There are two reasons which might contribute to the higher rate in older adults. First, the Beijing Government has provided annual seasonal influenza vaccination to older adults free of charge since 2007, and the vaccine coverage rate for this subpopulation increased substantially from 1.7% during 1999-2004 [16] to 48.7% in season 2014/2015. In most regions of China, older adults must pay for the seasonal influenza vaccine by self-finance, leading to a very low coverage rate of 1.9% which was estimated by a study in 2009, China [17]. However, the coverage of influenza vaccine in older adults of Beijing was much lower than that in Europe (61.1%) [9] and US (61.3%) [14], and could not meet the WHO's target of 75% vaccination coverage in 2010 [9]. Second, we found that older adults had better perceptions of severity of disease, side effects and awareness of free influenza vaccine policy in Beijing. This could lead to an increase in influenza vaccine uptake.

The current study documented that perceptions towards influenza and its vaccine were important factors for the uptake of influenza vaccine. Two recent meta-analyses obtained similar results that the factors including concerns about the danger of influenza and susceptibility to influenza, doubts about vaccine effectiveness and fears of side effects can influence the uptake of both seasonal and pandemic influenza vaccine [18,19]. In this study, half of participants didn't think “influenza is a serious disease”, two fifths didn't reported “I am afraid of catching influenza”, and 60% reported “I am afraid of side effects”. The results indicated that the information about severity of disease, susceptibility to influenza and side effects of vaccine should be delivered to the pubic when we are going to hold a vaccination campaign in Beijing.

According to our study, active recommendation from healthcare workers was the most important factor affecting influenza vaccination rates; and this result was also confirmed by the previous studies [8,20-21]. Although the health workers are the key persons to encourage people to be vaccinated against influenza, the vaccination coverage among this subpopulation was low in Beijing. A previous study found that only a quarter of the healthcare workers received the vaccine against pandemic influenza in season 2009/2010, and 60% concerned about side effects and half doubted about vaccine effectiveness [22]. Thus, health promotion activities should be conducted not only for the general population but also for the healthcare professionals.

Higher education is usually considered to be positively associated with the vaccination uptake [23]. In contrast, we found that a low level of education had a positive impact on the vaccination uptake; the result was consistent with our previous study [11]. In the recent years, media broadcast and internet discussions targeting at vaccine accidents occurred in China, and then caused social suspicion about the influenza vaccination and posed a negative effect on vaccination [24]. In comparison with the educated people, people with lower education are less likely to expose to such information and doubt about safety and effectiveness of vaccination [11]. The reason may explain the higher coverage rate among this subpopulation with lower education.

In this study, we found that suffering from a fever or chronic illness was associated with greater intentions to be vaccinated. The finding was consistent with Blank’s study, and could be explained by the increased perceptions of personal risk for them [25]. We also found that people with higher income or medical insurance and living in urban areas were more likely to get the vaccine and the higher capacity to pay and the better access to vaccines might be the main reason for their intentions to be vaccinated.

Strengths of our study are the large sample size of 7206 participants and the high response rate of 98.7%, indicating that the findings of our study are very representative and reliable. However, there are some limitations in our study. First, considering diversity of income levels and healthcare

access across regions, our observations might not be generalized well to other countries or regions. Second, because all the information was collected by a self-reported questionnaire, the investigators could not check the accuracy of participants' answers, which may lead to reporting bias in responses. Third, the respondents had to recall their experience of vaccination and thus a recall bias cannot be excluded.

CONCLUSIONS

This study demonstrated that the coverage rate of influenza vaccine in the general population of Beijing was 20.6% during the influenza season 2014-2015. The perceptions towards influenza and its vaccine and active recommendation from healthcare workers were associated with the uptake of influenza vaccine. However, a great number of people in Beijing feared of side effects, didn't concern about danger of influenza and susceptibility to influenza, and could not get active recommendation from healthcare workers. Therefore, vaccination campaigns targeted at increasing public perceptions should be implemented in the coming years.

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AUTHORS' CONTRIBUTIONS

Designed the study: WS, SJ, YP, WQ. Performed the data collection: WS, SJ, ZH, LH, CY, HW, LC, TY. Analyzed the data: WS, SJ. Drafted the manuscript: WS. Revised the manuscript: WS, SJ, YP, WQ. All authors have read and approved the final version of the manuscript.

COMPETIING INTERESTS

The authors declare that they have no competing interests.

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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	This study was not a cohort or case-control study.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*4-5*
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	This study was not a cohort or case-control study.
		(*e*) Describe any sensitivity analyses	The study is a population based survey and the study analysis is simple. Thus, there is no need to describe sensitivity analyses.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	The study is a population based survey and the study design is simple. Thus, there is no need to use a flow diagram.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	6-7
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	This study is not a cohort study.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	This study is not a cohort study.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	This study is not a *case-control study.*
		Cross-sectional study—Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-10

		(*b*) Report category boundaries when continuous variables were categorized	6-10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-10
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	There is no these analyses.
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China

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Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China

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ABSTRACT

Objectives

The present study aimed to estimate the influenza vaccination coverage rate and identify its determinants in older and younger adults in Beijing, China.

Methods

The survey was conducted among Chinese adults using a self-administered, anonymous questionnaire from May to June, 2015. The main outcome was the uptake of seasonal influenza vaccination. Multivariate logistic regression models were performed to identify the factors associated with influenza vaccine uptake.

Results

A total of 7106 participants completed the survey. The overall coverage rate was 20.6% (95% CI: 19.7-21.5%) in the 2014-2015 influenza season. The variables significantly associated with the uptake of seasonal influenza vaccination were being older adults aged ≥60 years (OR 3.3; 95% CI: 2.8-3.9), lower education (OR 1.8; 95% CI: 1.5-2.2), living in urban areas (OR 1.3; 95% CI: 1.1-1.5), having a chronic illness (OR 1.5; 95% CI: 1.3-1.8), having a fever in the past year (OR 1.4; 95% CI: 1.1-1.7), recommendations from healthcare workers (OR 4.5; 95% CI: 3.8-5.3), perceived susceptibility to disease (OR 1.2; 95% CI: 1.0-1.4), perceived effectiveness of vaccination (OR 1.8; 95% CI: 1.5-2.2), perceived side effects of vaccination (OR 0.7; 95% CI: 0.6-0.8) and awareness of free influenza vaccine policy in Beijing (OR 1.3; 95% CI: 1.1-1.7). Older adults were more likely to receive recommendations from healthcare professionals and perceive the severity of seasonal influenza, and less likely to worry about side effects of influenza vaccination.

Conclusions

The influenza vaccination coverage rate was relatively low in Beijing, China. Besides the free vaccination for older adults, age disparity in the vaccination rate between older and younger adults (48.7% versus 16.0%) may be explained by differing professional recommendations and public perceptions, which were the factors of vaccination. Vaccination campaigns targeted at increasing professional recommendations and public perceptions should be implemented in the coming years.

Key words

Influenza vaccine, Vaccination, Coverage, Factors, Adult

Strengths and limitations of this study:

Strengths of this study are the large sample size of 7206 participants and the high response rate of 98.7%, indicating that the findings are very representative and reliable.

This study is to analyze most of the influencing factors associated with uptake of the influenza vaccine (e.g., socio-economic factors, perceptions and impact of healthcare workers, etc).

The findings of this study inform seasonal influenza vaccine policy in China, a country where vaccination coverage among most groups is very low.

The main limitation is self-reported influenza vaccination uptake, which could result in possible recall bias.

INTRODUCTION

Seasonal influenza is a serious public health problem that causes substantial mortality and morbidity especially in the elderly and people with high risk conditions [1]. Worldwide, annual epidemics are estimated to result in about 3 to 5 million cases of severe illness and 250 000 to 500 000 deaths [2]. Influenza vaccination is the effective way to minimize the mortality and morbidity related to influenza [3-5]. Many public health organizations including China Centers for Disease Prevention and Control have recommended all people over the age of six months particularly these at high risk to get the influenza vaccine yearly [6]. Although seasonal influenza vaccination has been recommended for many years, a global study of seasonal influenza vaccine dose distribution found that seasonal influenza vaccination coverage remains low in many countries especially in low- and middle-income countries [7]. In most regions of China, people must pay for the seasonal influenza vaccine by self-finance, leading to a very low coverage rate of 1.5–2.2% between 2004 and 2014 [8].

Beijing is the capital of China with a population of about 20 millions. Convenient transportation and high population density make Beijing easy to be threatened by epidemics of both seasonal and pandemic influenza [9]. Since 2007, the Beijing Government, ahead of most cities in China, has provided the free influenza vaccines to people aged 60 or above and the students from primary or middle schools between September and November each year. Available data showed that the policy greatly increased the vaccine uptake rate in the population qualifying for free vaccination [10]. Thus, Beijing's experience can inform future government-funded reimbursement policies for seasonal influenza vaccination in other regions of China and as well as other developing countries.

Our pervious study in Beijing estimated influenza vaccination coverage rate of the general population to be 16.7% in 2008/2009, 16.9% in 2010/2011 and 21.8% during the 2009 pandemic, and the rates were much higher than other regions of China but lower than that of Western countries [11]. The coverage rate among older adults was much higher than that of younger adults in 2010 in Beijing, but lower than that of older adults from other countries with similar policy [12]. To improve the vaccination coverage, the influencing factors associated with the uptake of influenza vaccine need to be determined. These previous studies in Beijing only determined the demographics factors of influenza vaccination uptake [11]. Besides the free policy and demographics factors, many other factors including perceptions of personal risk, disease severity, effectiveness and side effects of vaccination and impact of healthcare workers may have effects on the uptake of influenza vaccine [13-14].

In this study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in the general population of Beijing. The aim of this study was to: (1) estimate the coverage rates among older and younger adults in the 2014-2015 influenza season; (2) identify the factors, including demographics factors, public perceptions and impact of healthcare workers, associated with the uptake of influenza vaccine; (3) find the reasons for age disparity in influenza vaccination rates between older and younger adults.

METHODS

Study participants

This study was a population-based survey in Beijing, China. The target population was Chinese adults living in Beijing for longer than half a year. The function $n=\mu_\alpha^2\times\pi\times(1-\pi)/\delta^2\times deff$ was used to calculate the sample size of each subgroup. We estimated a sample size of 576 participants per subgroup, based on $\mu_\alpha=1.96$, the influenza vaccination rate (π) =50%, the maximum permissible error (δ) =0.1π, and the design effect of complex sampling (deff) = 1.5. Considering residence (urban or suburban), and the different age groups (18–29, 30–39, 40–49, 50–59 and ≥60), and a no-answer rate of 25%, the optimal sample size for the present study was 7200 (576 participants per subgroup×10 subgroups×1.25). The participants were randomly selected from the 150 survey locations which were the same as that of the previous study [11]. To meet the sample size

requirement, all adults in each survey location were numbered and then 48 of them were selected at random.

Data collection

The survey was conducted using a self-administered, anonymous questionnaire from May to June, 2015. The questionnaire was available in Chinese and consisted of five sections: history of receiving seasonal influenza vaccine in the 2014-2015 influenza season, history of having a fever in the past year, recommendations from healthcare workers, public perceptions towards influenza and its vaccine and demographics information. (1) The history of receiving seasonal influenza vaccine was assessed by asking: "Have you received seasonal influenza vaccine during the last season (2014-2015)?" with the response option of "yes" or "no". (2) Recommendations from healthcare workers were assessed by asking: "Did healthcare workers recommend seasonal influenza vaccine to you during the last season (2014-2015)?" with the response option of "yes" or "no". (3) The history of having a fever in the past year was assessed by asking: "Have you ever had a fever in the past year?" with the response option of "yes" or "no". (4) To assess public perceptions towards influenza and its vaccine, we asked the following yes/no questions: "Do you think influenza is a serious disease?", "Do you think you are afraid of catching influenza during an epidemic?", "Do you think vaccine can prevent influenza infections?", "Are you scared of vaccine side effects?", "Do you know the free influenza vaccine policy in Beijing?". (5) To collect information of demographics characteristics, the participants were asked to report their sex (female or male), age (continuous), education attainment (primary school or illiterate, junior high school, senior high school, 3 year college graduate or above), residence (urban or suburban), monthly income per capita (0-2000 or >2000 yuans, US $100=680 yuans), family population (continuous), number of children within the family (continuous) and history of having a chronic illness (yes or no). The average monthly income of Beijing residents was 3659 and 1685 yuans in urban and suburban areas respectively. All the questions were developed based on measures adapted from our previous study and the existing literatures [11,13-14].

All interviews were undertaken by local healthcare workers. Before each questionnaire was distributed, all investigators were required to explain the purpose, procedure and confidentiality agreement of this study to respondents, and written informed consents were obtained from them. In most case, the participants completed the questionnaires by themselves. For the participants who could not understand the questionnaires, the investigators would read and explain the questionnaires to them.

Ethics Statement

This study was approved by the Institutional Review Board and Human Research Ethics Committee of Beijing Center for Disease Prevention and Control. Anonymity of the participants was guaranteed to participants, and informed consent was required during the surveys.

Statistical analysis

The main outcome was the uptake of seasonal influenza vaccination in the 2014-2015 influenza season. Descriptive analysis was performed to generate frequency distributions of the survey variables, and differences between the subgroups were tested by Pearson's Chi-square test. The numbers of participants reporting missing data were listed in the tables. Weighted analysis was conducted to calculate the weighted coverage rates, accounting for the age, sex, and residence of Beijing population, as reported in the 2010 Census of Beijing [15]. Multivariate logistic regression models were performed to examine the factors associated with uptake of the vaccine, and odd ratios (OR) and their 95% confidence intervals (95% CI) were used as measures of association. All the statistical tests were two-sided, with a p value <0.05 considered to be statistically significant. Data entry was performed using Epidata software Version 3.1. Data analyses were carried out using SPSS Version 20.0 (SPSS Inc, Chicago, IL).

RESULTS

Demographic characteristics of study participants

Of the 7200 subjects approached, 7106 participants completed the survey. Of them, approximately half were female (n=3614, 50.9%) and lived in urban areas (n=3468, 48.8%). The distribution of age was as follows: 18-29: 20.5% (n=1450), 30-39: 20.1% (n=1424), 40-49: 20.6% (n=1461), 50-59: 19.6% (n=1391), ≥ 60 years: 19.2% (n=1362). Almost all participants (n=6710, 95.7%) had no or one child in their family. Only one tenth (n=730, 10.3%) of participants reported a low education level (illiterate or primary school). Three out of ten (n=2149, 30.2%) participants reported having a chronic illness, and one eighth (n=894, 12.6%) had a fever in the past year. Approximately three fifths (n=4168, 58.7%) reported that they had got recommendations from healthcare workers. (Table 1)

Weighted coverage rates of seasonal influenza vaccine

Weighted coverage rate of seasonal influenza vaccine was 20.6% (95% CI: 19.7-21.5%) among adults in Beijing during the 2014-2015 influenza season. Considering the difference between the age groups, the coverage rates were 48.7% (95% CI: 46.0-51.4%) and 16.0% (95%: 14.1-17.9%) in older and younger adults respectively.

Univariate analysis of variables affecting the uptake of seasonal influenza vaccination

Overall, 1610 (22.7%) participants reported that they had received seasonal influenza vaccine during the last season (2014-2015). The rates didn't differ by sex and residence (P>0.05). The rate among older adults was significantly higher than that among younger people (P<0.05). The rates decreased with the increasing education levels, from 43.8% of illiterate participants or those with the education of primary school to 18.7% of those with 3-year college graduate or higher (P<0.05). The significantly different rates were observed between the two categories of income (27.0% vs. 21.0%, P<0.05). The rates decreased with the family size, from 28.7% of participants whose family size were 1-2 to 21.5% of those whose family size were ≥6 (P<0.05). The rates were significantly higher among people having a chronic illness (35.5% vs. 17.1%, P<0.05) or having a fever in the past year (27.5% vs. 22%, P<0.05). Participants who had got recommendations from healthcare workers were more likely to be vaccinated (33.0% vs. 8.0%, P<0.05). Participants who perceived severity of disease, susceptibility to disease, effectiveness of vaccination and free influenza vaccine policy in Beijing were more likely to be vaccinated, and those who worried about side effects of vaccination were less likely to be vaccinated (P<0.05). (Table 1)

Table 1 Univariate analysis of variables affecting the uptake of seasonal influenza vaccination in Beijing during the 2014-2015 influenza season

Variables		Total participants		Vaccinated		Non-Vaccinated		P value§
		N	%	n	%*	n	%*	
Sex								
	Male	3484	49.1	778	22.3	2706	77.7	0.541
	Female	3614	50.9	829	22.9	2785	77.1	
	Missing	8		3		5		
Age (years)								
	18-29	1450	20.5	216	14.9	1234	85.1	<0.001
	30-39	1424	20.1	212	14.9	1212	85.1	
	40-49	1461	20.6	203	13.9	1258	86.1	
	50-59	1391	19.6	302	21.7	1089	78.3	
	≥60	1362	19.2	672	49.3	690	50.7	
	Missing	18		5		13		
Highest education								
	primary school or illiterate	730	10.3	320	43.8	410	56.2	<0.001
	junior high school	1850	26.1	418	22.6	1432	77.4	

	senior high school	2167	30.6	422	19.5	1745	80.5	
	3 year college graduate or above	2334	33.0	437	18.7	1897	81.3	
	Missing	25		13		12		
Residence								
	Suburban	3638	51.2	805	22.1	2833	77.9	0.275
	Urban	3468	48.8	805	23.2	2663	76.8	
	Missing	0		0		0		
Monthly income per capita (yuans) ǂ								
	0-2000	1887	27.3	509	27.0	1378	73.0	<0.001
	>2000	5023	72.7	1056	21.0	3967	79.0	
	Missing	196		45		151		
Family population								
	1-2	547	7.7	157	28.7	390	71.3	<0.001
	3	1831	25.8	487	26.6	1344	73.4	
	4	2415	34.0	458	19.0	1957	81.0	
	5	1179	16.6	264	22.4	915	77.6	
	≥6	1130	15.9	243	21.5	887	78.5	
	Missing	4		1		3		
Number of children in the family								
	0	3915	55.8	959	24.5	2956	75.5	<0.001
	1	2795	39.9	548	19.6	2247	80.4	
	≥2	300	4.3	65	21.7	235	78.3	
	Missing	96		38		58		
History of having a chronic illness								
	Yes	2149	30.2	763	35.5	1386	64.5	<0.001
	No	4957	69.8	847	17.1	4110	82.9	
	Missing	0		0		0		
History of having a fever in the past year								
	Yes	894	12.6	246	27.5	648	72.5	<0.001
	No	6194	87.4	1363	22.0	4831	78.0	
	Missing	18		1		17		
Recommendations from healthcare workers								
	Yes	4168	58.7	1376	33.0	2792	67.0	<0.001
	No	2938	41.3	234	8.0	2704	92.0	
	Missing	0		0		0		
Perceived severity of disease (influenza is a serious disease)								
	Yes	4328	52.1	1044	24.1	3284	75.9	<0.001
	No	2778	47.9	566	20.4	2212	79.6	
	Missing	0		0		0		
Perceived susceptibility to disease (I								

am afraid of catching influenza during an epidemic)								
	Yes	4320	60.8	1055	24.4	3265	75.6	<0.001
	No	2786	39.2	555	19.9	2231	80.1	
	Missing	0		0		0		
Perceived effectiveness of vaccination (influenza vaccine can prevent infections)								
	Yes	5793	81.5	1432	24.7	4361	75.3	<0.001
	No	1313	18.5	178	13.6	1135	86.4	
	Missing	0		0		0		
Perceived side effects of vaccination (I am afraid of side effects)								
	Yes	4273	60.1	921	21.6	3352	78.4	0.006
	No	2833	39.9	689	24.3	2144	75.7	
	Missing	0		0		0		
Awareness of free influenza vaccine policy in Beijing								
	Yes	5958	83.8	1483	24.9	4475	75.1	<0.001
	No	1148	16.2	127	11.1	1021	88.9	
	Missing	0		0		0		

Note: Missing referred to "how many people did not answer this question".
＊%=n/N.
§Pearson's Chi-square test.
ǂUS $100=680 yuans.

Multiple logistic regression analysis for the factors associated with the uptake of seasonal influenza vaccination

As shown in Table 2, the factors associated with the uptake of seasonal influenza vaccination were being older adults aged ≥60 years (OR 3.3; 95% CI: 2.8-3.9), lower education (OR 1.8; 95% CI: 1.5-2.2), living in urban areas (OR 1.3; 95% CI: 1.1-1.5), having a chronic illness (OR 1.5; 95% CI: 1.3-1.8), having a fever in the past year (OR 1.4; 95% CI: 1.1-1.7), recommendations from healthcare workers (OR 4.5; 95% CI: 3.8-5.3), perceived susceptibility to disease (OR 1.2; 95% CI: 1.0-1.4), perceived effectiveness of vaccination (OR 1.8; 95% CI: 1.5-2.2), perceived side effects of vaccination (OR 0.7; 95% CI: 0.6-0.8) and awareness of free influenza vaccine policy in Beijing (OR 1.3; 95% CI: 1.1-1.7).

For older adults, the factors associated with the uptake of seasonal influenza vaccination were lower education (OR 1.6; 95% CI: 1.2-2.1), having a chronic illness (OR 1.9; 95% CI: 1.5-2.4), recommendations from healthcare workers (OR 5.4; 95% CI: 3.9-7.4), perceived susceptibility to disease (OR 1.5; 95% CI: 1.2-2.0), perceived side effects of vaccination (OR 0.6; 95% CI: 0.4-0.7) and awareness of free influenza vaccine policy in Beijing (OR: 1.9; 95% CI 1.2-2.9). For younger adults, the factors affecting the uptake of influenza vaccination were lower education (OR 1.9; 95% CI: 1.4-2.6), living in urban areas (OR 1.4; 95% CI: 1.2-1.6), having a chronic illness (OR 1.4; 95% CI: 1.2-1.7), having a fever in the past year (OR 1.4; 95% CI: 1.1-1.8), recommendations from healthcare workers (OR 4.5; 95% CI: 3.7-5.4), perceived effectiveness of vaccination (OR 2.2; 95% CI: 1.7-2.8) and perceived side effects of vaccination (OR 0.8; 95% CI: 0.7-1.0). (Table 2)

Table 2 Multiple logistic regression analysis for the factors associated with the uptake of seasonal

influenza vaccination in Beijing during the 2014-2015 influenza season

Variables	All adults (N=7106)		Older adults (Age≥60) (N=1362)		Younger adults (Age=18-59) (N=5726)	
	Vaccinated %(n/N)	Adjusted OR(95%CI) §	Vaccinated %(n/N)	Adjusted OR(95%CI) §	Vaccinated %(n/N)	Adjusted OR(95%CI)
Sex						
Male	22.3(778/3484)	NS	49.9(342/685)	NS	15.5(433/2788)	NS
Female	22.9(829/3614)		48.7(328/674)		17.0(499/2933)	
Age (years)						
18-59	16.3(933/5726)	1.0(referent)	-		16.3(933/5726)	
≥60	49.3(672/1362)	3.3(2.8-3.9)	49.3(672/1362)		-	
Highest education						
primary school or illiterate	43.8(320/730)	1.8(1.5-2.2)	58.3(246/422)	1.6(1.2-2.1)	24.1(74/307)	1.9(1.4-2.6)
junior high school or above	22.6(1277/6351)	1.0(referent)	45.1(419/929)	1.0(referent)	15.8(853/5405)	1.0(referent)
Residence						
Suburban	22.1(805/3638)	1.0(referent)	51.1(365/714)	NS	15.0(438/2919)	1.0(referent)
Urban	23.2(805/3468)	1.3(1.1-1.5)	47.4(307/648)		17.6(495/2807)	1.4(1.2-1.6)
Monthly income per capita (yuans) ǂ						
0-2000	27.0(509/1887)	NS	54.8(276/504)	NS	16.8(231/1378)	NS
>2000	21.0(1056/5023)		46.5(384/825)		16.0(669/4186)	
Family population						
1-2	28.7(157/547)	NS	53.7(95/177)	NS	16.8(62/368)	NS
3	26.6(487/1831)		50.2(256/510)		17.4(229/1314)	
4	19.0(458/2415)		42.2(89/211)		16.7(368/2203)	
5	22.4(264/1179)		55.0(110/200)		15.7(153/974)	
≥6	21.5(243/1130)		46.2(121/262)		14.0(121/865)	
Number of children in the family						
0	24.5(959/3915)	NS	51.2(460/899)	NS	16.6(498/3008)	NS
1	19.6(548/2795)		44.1(171/388)		15.6(375/2398)	
≥2	21.7(65/300)		53.2(25/47)		15.9(40/252)	
History of having a chronic illness						
Yes	35.5(763/2149)	1.5(1.3-1.8)	54.3(490/902)	1.9(1.5-2.4)	21.9(271/1239)	1.4(1.2-1.7)
No	17.1(847/4957)	1.0(referent)	39.6(182/460)	1.0(referent)	14.8(662/4487)	1.0(referent)
History of having a fever in the past year						
Yes	27.5(246/894)	1.4(1.1-1.7)	54.8(103/188)	NS	20.4(143/702)	1.4(1.1-1.8)
No	22.0(1363/6194)	1.0(referent)	48.5(568/1170)		15.8(790/5010)	1.0(referent)
Recommendations from healthcare workers						
Yes	33.0(1376/4168)	4.5(3.8-5.3)	59.6(594/996)	5.4(3.9-7.4)	24.6(777/3160)	4.5(3.7-5.4)
No	8.0(234/2938)	1.0(referent)	21.3(78/366)	1.0(referent)	6.1(156/2566)	1.0(referent)

Perceived severity of disease (influenza is a serious disease)						
Yes	24.1(1044/4328)	NS	48.5(452/931)	NS	17.4(590/3390)	NS
No	20.4(566/2778)		51.0(220/431)		14.7(343/2336)	
Perceived susceptibility to disease (I am afraid of catching influenza during an epidemic)						
Yes	24.4(1055/4320)	1.2(1-1.4)	52.8(443/839)	1.5(1.2-2)	17.6(609/3469)	NS
No	19.9(555/2786)	1.0(referent)	43.8(229/523)	1.0(referent)	14.4(324/2257)	
Perceived effectiveness of vaccination (influenza vaccine can prevent infections)						
Yes	24.7(1432/5793)	1.8(1.5-2.2)	51.7(582/1125)	NS	18.2(847/4656)	2.2(1.5-2.8)
No	13.6(178/1313)	1.0(referent)	38.0(90/237)		8.0(86/1070)	1.0(referent)
Perceived side effects of vaccination (I am afraid of side effects)						
Yes	21.6(921/4273)	0.7(0.6-0.8)	46.5(342/736)	0.6(0.4-0.7)	16.3(576/3525)	0.8(0.7-1)
No	24.3(689/2833)	1.0(referent)	52.7(330/626)	1.0(referent)	16.2(357/2201)	1.0(referent)
Awareness of free influenza vaccine policy in Beijing						
Yes	24.9(1483/5958)	1.3(1.1-1.7)	53.0(629/1186)	1.9(1.2-2.9)	17.9(849/4755)	NS
No	11.1(127/1148)	1.0(referent)	24.4(43/176)	1.0(referent)	8.7(84/971)	

Note: Because there were eighteen participants who did not answer the question of age, the sum number of the two age groups was not equal to the sample size of all adults.
OR= odd ratios; 95% CI=95% confidence intervals.
NS: not significant.
§Multiple logistic regression analysis.
ǂUS $100=680 yuans.

Comparison of disease history, recommendations from healthcare workers and public perceptions between older and younger adults

For all adults, 5793 (81.5%) reported “influenza vaccine can prevent infections” and 5958 (83.8%) reported “awareness of free influenza vaccine policy in Beijing”. Approximately three fifths of participants reported “I am afraid of catching influenza during an epidemic” (n=4320) and “I am afraid of side effects” (n=4273). Only half of them reported “Influenza is a serious disease” (n=3720). Pearson’s Chi-square tests indicated that older adults were more likely to get recommendations from healthcare workers, have a chronic illness, perceive severity of disease and be aware of free influenza vaccine policy in Beijing; and less likely to worry about side effects of vaccination (P<0.05, Table 3). Compared to well-educated participants, lower-educated participants were less likely to report "I am afraid of side effects" and “influenza vaccine can prevent infections”, whereas more likely to report "influenza is a serious disease". Moreover, for older adults, lower-educated participants reported “receive recommendations from healthcare workers” more frequently than well-educated participants; for younger adults, lower-educated participants were more likely to have a chronic illness (P<0.05, Table 4).

Table 3 Comparison of disease history, recommendations from healthcare workers and public perceptions between older and younger adults in Beijing during the 2014-2015 influenza season

Factors		All adults (N=7106)		Younger adults (Age=18-59) (N=5726)		Older adults (Age≥60) (N=1362)		P value§
		N	%	N	%	N	%	
History of having a fever in the past year								
	Yes	894	12.6	702	12.3	188	13.8	0.121
	No	6194	87.4	5010	87.7	1170	86.2	
	Missing	18		14		4		
History of having a chronic illness								
	Yes	4957	69.8	1239	21.6	902	66.2	<0.001
	No	2149	30.2	4487	78.4	460	33.8	
	Missing	0		0		0		
Recommendations from healthcare workers								
	Yes	4168	58.7	3160	55.2	996	73.1	<0.001
	No	2938	41.3	2566	44.8	366	55.2	
	Missing	0		0		0		
Perceived severity of disease (influenza is a serious disease)								
	Yes	3702	52.1	2934	51.2	762	55.9	0.002
	No	3404	47.9	2792	48.8	600	44.1	
	Missing	0		0		0		
Perceived susceptibility to disease (I am afraid of catching influenza during an epidemic)								
	Yes	4320	60.8	3469	60.6	839	61.6	0.489
	No	2786	39.2	2257	39.4	523	38.4	
	Missing	0		0		0		
Perceived effectiveness of vaccination (influenza vaccine can prevent infections)								
	Yes	5793	81.5	4656	81.3	1125	82.6	0.271
	No	1313	18.5	1070	18.7	237	17.4	
	Missing	0		0		0		
Perceived side effects of vaccination (I am afraid of side effects)								
	Yes	4273	60.1	3525	61.6	736	54.0	<0.001
	No	2833	39.9	2201	38.4	626	46.0	
	Missing	0		0		0		
Awareness of free influenza vaccine policy in Beijing								
	Yes	5958	83.8	4755	83.0	1186	87.1	<0.001
	No	1148	16.2	971	17.0	176	12.9	
	Missing	0		0		0		

Note: Missing referred to “how many people did not answer this question”. Because there were

eighteen participants who did not answer the question of age, the sum number of the two age groups was not equal to the sample size of all participants.
§Pearson's Chi-square test.

Table 4 Comparison of disease history, recommendations from healthcare workers and public perceptions between adults with two different levels of education in Beijing during the 2014-2015 influenza season

Factors		Younger adults (Age=18-59) (N=5726)					Older adults (Age≥60) (N=1362)				
		primary school or illiterate		junior high school or above		P value§	primary school or illiterate		junior high school or above		P value§
		n	%	n	%		n	%	n	%	
History of having a fever in the past year											
	Yes	35	11.4	666	12.4	0.636	50	11.8	138	14.9	0.131
	No	271	88.6	4726	87.6		372	88.2	787	85.1	
	Missing	1		13			0		4		
History of having a chronic illness											
	Yes	121	39.4	1117	20.7	<0.001	288	68.2	610	65.7	0.351
	No	186	60.6	4288	79.3		134	31.8	319	34.3	
	Missing	0		0			0		0		
Recommendations from healthcare workers											
	Yes	173	56.4	2978	55.1	0.185	327	77.5	659	70.9	0.012
	No	134	43.6	2427	44.9		95	22.5	270	29.1	
	Missing	0		0			0		0		
Perceived severity of disease (influenza is a serious disease)											
	Yes	226	73.6	3156	58.4	<0.001	309	73.2	612	65.9	0.007
	No	81	26.4	2249	41.6		113	26.8	317	34.1	
	Missing	0		0			0		0		
Perceived susceptibility to disease (I am afraid of catching influenza during an epidemic)											
	Yes	171	55.7	3292	60.9	0.069	258	61.1	572	61.6	0.879
	No	136	44.3	2113	39.1		164	38.9	357	38.4	
	Missing	0		0			0		0		
Perceived effectiveness of vaccination (influenza vaccine can prevent infections)											
	Yes	232	75.6	4415	81.7	0.007	333	78.9	781	84.1	0.021
	No	75	24.4	990	18.3		89	21.1	148	15.9	
	Missing	0		0			0		0		
Perceived side effects of vaccination (I am afraid of side effects)											
	Yes	167	54.4	3351	62.0	0.008	195	46.2	535	57.6	<0.001
	No	140	45.6	2024	38.0		227	53.8	394	42.4	
	Missing	0		0			0		0		

Awareness of free influenza vaccine policy in Beijing										
	Yes	251	81.8	4494	83.1	0.529	353	83.6	822	88.5	0.014
	No	56	18.2	911	16.9		69	16.4	107	11.5	
	Missing	0		0			0		0		

Note: Missing referred to "how many people did not answer this question". Because there were 25 participants who did not answer the question of education, the sum number of the two education groups was not equal to the sample size of all participants.
§Pearson's Chi-square test.

DISCUSSION

In this study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in the general population of Beijing. Our survey showed that vaccination coverage rates in the general population of Beijing was 20.6% during season 2014/2015, which was nearly to European countries [16] (25.0% in UK, 27.4% in Germany, 21.8% in Spain, 24.2% in France, and 24.4% in Italy) but much lower than US [17] (39.7% in 2014/2015). In Beijing, the coverage rate during season 2014/2015 was consistent with that of season 2009/2010 (21.8%), but higher than that of season 2008/2009 and 2010/2011 (16.9% and 16.7%) [11], and an increase in coverage was observed after season 2010/2011. Since 2007, the free influenza vaccines have been provided to older adults aged ≥60 years and the students from primary and middle school in Beijing. Meanwhile, annual influenza immunization campaigns are conducted each year. The immunization activities including health education or promotion and better access to vaccine might increase the coverage of influenza vaccine in Beijing [18].

The present study showed that older adults were more likely to be vaccinated than younger adults. There are two reasons which might contribute to the higher vaccination coverage rate in older adults. First, the free vaccination policy was a key factor. The Beijing Government has provided annual seasonal influenza vaccination to older adults free of charge since 2007, and the vaccine coverage rate for this subpopulation increased substantially from 1.7% during 1999-2004 [19] to 48.7% in season 2014/2015. In most regions of China, older adults must pay for the seasonal influenza vaccine by self-finance, leading to a very low coverage rate of 1.5-2.2% between 2004 to 2014 [8]. However, the coverage of influenza vaccine in older adults of Beijing was much lower than that in Europe (61.1%) [16] and US (61.3%) [17], and could not meet the WHO's target of 75% vaccination coverage in 2010 [16]. Second, we found that older adults were more likely to receive recommendations from healthcare professionals and perceive the severity of seasonal influenza, and less likely to worry about side effects of influenza vaccination. And these factors could lead to an increase in influenza vaccine uptake.

Recommendations from healthcare workers was the most important factor affecting the uptake of influenza vaccination in both older and younger adults; and this result was also confirmed by the previous studies [20-21]. Although the healthcare workers are the key persons to encourage people to be vaccinated against influenza, the vaccination coverage among this subpopulation was low in Beijing. A previous study found that only a quarter of the healthcare workers received the vaccine against pandemic influenza in season 2009/2010, and 60% concerned about side effects and half doubted about vaccine effectiveness [22]. Thus, health promotion activities should be conducted not only for the general population but also for the healthcare professionals, and more measures should be taken to motivate healthcare workers to provide recommendations for influenza vaccination.

Consistent with two recent meta-analyses [13,23], the current study documented that public perceptions including concerns about the susceptibility to influenza, doubts about vaccine effectiveness and fears of side effects can influence the uptake of influenza vaccine. Regarding the difference between younger and older adults, perceived susceptibility to influenza and awareness of free influenza vaccine policy were the risk factors for older adults, perceived effectiveness of vaccination was a risk factor for younger adults, and perceived side effects of vaccination was for

both younger and older adults. In this study, two fifths didn't reported “I am afraid of catching influenza”, 18.5% didn't reported “influenza vaccine can prevent infections”, and 60% reported “I am afraid of side effects”. The results indicated that the correct information about severity of disease, susceptibility to influenza, vaccine effectiveness and side effects of vaccine should be delivered to the pubic when we are going to hold a vaccination campaign in Beijing.

Higher education is usually considered to be positively associated with the vaccination uptake [24]. In contrast, we found that a low level of education had a positive impact on the vaccination uptake; the result was consistent with our previous study [11]. In this study, multiple logistic regression by age showed that lower education was a risk factor of vaccination in both older and younger adults, and income was not a risk factor. That was to say, influenza vaccination was significantly influenced by education status, independent of age and income. Several reasons might contribute to the higher coverage rate among lower-educated people. First, in the recent years, media broadcast and internet discussions targeting at vaccine accidents have caused social suspicion about influenza vaccination in China [25]. Lower-educated people are less likely to expose to such information [11], which might have a negative effect on vaccination. Our results, which supported this assumption, were as follows: For both younger and older adults, lower-educated participants were less likely to report "I am afraid of side effects", whereas more likely to report "influenza is a serious disease". Second, this study found that lower-educated older adults reported “receive recommendations from healthcare workers” more frequently than those with better education. Third, for younger adults, lower-educated participants were more likely to have a chronic illness, which was the risk factor of vaccination in the current study.

In this study, we found that suffering from a fever or chronic illness was associated with greater intentions to be vaccinated. The finding was consistent with Blank’s study, and could be explained by the increased perceptions of personal risk for them [26]. We also found that younger adults living in urban areas were more likely to get the vaccine than those from suburban areas and the better access to vaccines might be the main reason for their intentions to be vaccinated.

Strengths of our study are the large sample size of 7206 participants and the high response rate of 98.7%, indicating that the findings of our study are very representative and reliable. However, there are some limitations in our study. First, considering diversity of income levels and healthcare access across regions, our observations might not be generalized well to other countries or regions. Second, because all the information was collected by a self-reported questionnaire, the investigators could not check the accuracy of participants’ answers, which may lead to reporting bias in responses. Third, the respondents had to recall their experience of vaccination and thus a recall bias cannot be excluded.

CONCLUSIONS

This study demonstrated that the overall coverage rate of influenza vaccine was 20.6% among adults in Beijing during the influenza season 2014-2015. Recommendations from healthcare professionals, perceived susceptibility to disease, perceived effectiveness of vaccination, and awareness of free influenza vaccine policy were positively associated with the uptake of influenza vaccine, and perceived side effects of vaccination posed a negative impact on vaccination. However, a great number of Beijing residents feared of side effects, doubts about vaccine effectiveness, didn’t concern about susceptibility to influenza, and could not get recommendations from healthcare workers. Therefore, vaccination campaigns targeted at increasing professional recommendations and public perceptions should be implemented in the coming years.

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AUTHORS' CONTRIBUTIONS

Designed the study: WS, SJ, YP, WQ. Performed the data collection: WS, SJ, ZH, LH, CY, HW, LC, TY. Analyzed the data: WS, SJ. Drafted the manuscript: WS. Revised the manuscript: WS, SJ, YP, WQ. All authors have read and approved the final version of the manuscript.

COMPETIING INTERESTS

The authors declare that they have no competing interests.

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DATA SHARING STATEMENT

Other data can be requested by emailing the corresponding author.

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Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China

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ABSTRACT

Objectives

The present study aimed to estimate the influenza vaccination coverage rate in Beijing, China, and identify its determinants in older and younger adults.

Methods

A survey was conducted among Chinese adults using a self-administered, anonymous questionnaire in May–June, 2015. The main outcome was seasonal influenza vaccination uptake. Multivariate logistic regression models were performed to identify factors associated with uptake.

Results

A total of 7106 participants completed the questionnaire. The overall coverage rate was 20.6% (95% confidence interval [CI]: 19.7–21.5%) in the 2014/2015 influenza season. Variables significantly associated with seasonal influenza vaccination uptake were being aged ≥60 years (odds ratio [OR] 3.3; 95% CI: 2.8–3.9), lower education (OR 1.8; 95% CI: 1.5–2.2), living in an urban area (OR 1.3; 95% CI: 1.1–1.5), having a chronic illness (OR 1.5; 95% CI: 1.3–1.8), having a fever within the past year (OR 1.4; 95% CI: 1.1–1.7), recommendations from healthcare workers (OR 4.5; 95% CI: 3.8–5.3), perceived susceptibility to the disease (OR 1.2; 95% CI: 1.0–1.4), perceived effectiveness of vaccination (OR 1.8; 95% CI: 1.5–2.2), perceived side effects of vaccination (OR 0.7; 95% CI: 0.6–0.8) and awareness of the free influenza vaccine policy in Beijing (OR 1.3; 95% CI: 1.1–1.7). Older adults were more likely to receive recommendations from healthcare professionals and perceive the severity of seasonal influenza, and less likely to worry about side effects of vaccination.

Conclusions

The influenza vaccination coverage rate was relatively low in Beijing. Apart from free vaccinations for older adults, age disparity in the rate between older and younger adults (48.7% vs. 16.0%) may be explained by differing professional recommendations and public perceptions, which were factors for vaccination. Vaccination campaigns targeting increasing professional recommendations and public perceptions should be implemented in the coming years.

Key words

Influenza vaccine, Vaccination, Coverage, Factors, Adult

Strengths and limitations of this study:

Strengths of this study were the large sample size of 7206 participants and high response rate of 98.7%, indicating high representation and reliability in the findings.

The study provided new data to help fill the knowledge gap with respect to factors associated with influenza vaccination uptake in older and younger adults in Beijing.

Self-reported influenza vaccination uptake may result in recall bias.

The causal relationships could not be established because of the cross-sectional design.

INTRODUCTION

Seasonal influenza is a weighty public health problem that causes substantial mortality and morbidity, especially among older people and others with high-risk conditions [1]. Worldwide, annual epidemics are estimated to result in about three to five million cases of severe illness and 250,000–500,000 deaths [2]. Vaccination is an effective way to minimize influenza-related mortality and morbidity [3-5]; many public health organizations, including the China Centers for Disease Prevention and Control, have recommended all people over 6 months old, particularly those at high risk, receive the influenza vaccine annually [6]. Although seasonal vaccination has been recommended for many years, a global study of seasonal influenza vaccine dose distribution found that coverage remains low in many countries, especially low- and middle-income countries [7]. People in most regions of China bear the full cost of the vaccine; this led to the very low 1.5–2.2% coverage rate between 2004 and 2014 [8].

The Chinese capital of Beijing has a population of about 20 millions. Abundant and convenient transportation and high population density make the city an easily affected host for both seasonal and pandemic influenza [9]. Since 2007, the Beijing Government, ahead of governments in most cities in China, has provided free influenza vaccines to people aged ≥60 years, and for students in primary or middle schools, between September and November of each year. Available data show the policy greatly increased the vaccine uptake rate in the qualifying population [10]. Therefore, Beijing's experience can serve to inform future government-funded reimbursement policies for seasonal influenza vaccination in other regions of China, as well as in other developing countries.

Our previous study in Beijing estimated the influenza vaccination coverage rate of the general population at 16.7% in 2008/2009, 16.9% in 2010/2011 and 21.8% during the 2009 pandemic. The rates were much higher than in other regions of China, yet lower than those of Western countries [11]. Coverage was much higher among older adults than younger adults in Beijing in 2010, but lower than that among older adults in other countries with similar policies [12]. The influencing factors associated with uptake of the influenza vaccine need to be determined in order to improve coverage. Meanwhile, previous studies in Beijing only determined demographics factors for uptake [11]. Apart from a free vaccination policy and demographics, many other factors, including perceptions of personal risk, disease severity, effectiveness and side effects of vaccination, and the related impact of healthcare workers may also affect uptake [13-14].

In the present study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in Beijing's general population. The study aimed to: (1) estimate coverage rates among older adults aged ≥60 years and younger adults aged <60 years in the 2014/2015 influenza season; (2) identify the factors–including demographics factors, public perceptions and impact of healthcare workers–associated with uptake; and (3) find the reasons behind age disparity between younger and older adults in influenza vaccination rates.

METHODS

Study participants

This study employed a population-based survey in the Beijing metropolitan area. The target population was Chinese adults living in Beijing for longer than half a year. The function $n = \mu_\alpha^2 \times \pi \times (1-\pi) / \delta^2 \times$ deff was used to calculate the sample size of each subgroup. We estimated a sample size of 576 participants per subgroup, based on μ_α=1.96, influenza vaccination rate (π) =50%, maximum permissible error (δ) =0.1π, and design effect of complex sampling (deff) = 1.5. Considering area of residence (urban or suburban), and different age groups (18–29, 30–39, 40–49, 50–59 and ≥60 years), and a no-response rate of 25%, the optimal sample size for the present study was 7200 (576 participants per subgroup × 10 subgroups × 1.25). Participants were randomly selected from 150 survey locations that were the same as in the previous study [11]. All adults in each survey location were numbered, and then 48 were randomly selected to meet the sample size requirement.

Data collection

The survey was conducted using a self-administered, anonymous questionnaire in May–June, 2015. The questionnaire was in Chinese and consisted of five sections: receiving seasonal influenza vaccine in the 2014/2015 influenza season, having a fever within the past year, recommendations from healthcare workers, public perceptions toward influenza and its vaccine, and demographics. (1) History of receiving the vaccine was assessed using the yes/no question: "Did you receive the seasonal influenza vaccine during the previous season (2014/2015)?" (2) Recommendations from healthcare workers were assessed using: "Did healthcare workers recommend the seasonal influenza vaccine to you during the previous season (2014/2015)?" (3) History of having a fever within the past year was assessed using: "Have you had a fever within the past year?" (4) To assess public perceptions toward influenza and its vaccine, the following yes/no questions were asked: "Do you think influenza is a serious disease?", "Are you afraid of catching influenza during an epidemic?", "Do you think the vaccine can prevent influenza infection?", "Are you scared of the vaccine's side effects?", and "Do you know about the free influenza vaccine policy in Beijing?". (5) Regarding demographics information, the participants were asked to report their sex (female or male), age (continuous), highest educational attainment (primary school or none, junior high school, senior high school, 3-year college graduate or above), residence (urban or suburban), monthly income per capita (0–2000 or >2000 yuans; US$100 is equivalent to approximately 680 yuan), family population (continuous), number of children in the family (continuous) and history of chronic illness (yes or no). The average monthly income of Beijing residents was 3659 and 1685 yuan in urban and suburban areas respectively. All questions were developed based on measures adapted from our previous study and from the existing literatures [11,13-14].

Local healthcare workers performed all interviews. Before each questionnaire was distributed, all investigators were required to explain to respondents the purpose, procedures and confidentiality agreement for the study, and written informed consent was accordingly obtained. In most cases, the participants completed the questionnaires independently. The investigators read and explained the questionnaires to candidates who were unable to sufficiently understand them.

Ethics statement

This study was approved by the Institutional Review Board and Human Research Ethics Committee of the Beijing Center for Disease Prevention and Control. Anonymity of participants was guaranteed, and informed consent was required for performing the surveys.

Statistical analysis

The main outcome was seasonal influenza vaccination uptake in the 2014/2015 influenza season. Descriptive analysis was performed to generate frequency distributions of the survey variables, and differences between the subgroups were tested using Pearson's chi-square test. The tables list the numbers of participants for whom missing data were reported. Weighted analysis was conducted to calculate weighted coverage rates, accounting for age, sex, and residence of those in the Beijing population, as reported in the 2010 Census of Beijing [15]. Multivariate logistic regression models were performed to examine the factors associated with uptake of the vaccine, and the odds ratio (OR) and 95% confidence intervals (95% CI) were used as measures of association. All statistical tests were two-sided, with $P<0.05$ considered statistically significant. Data entry was performed using Epidata software Version 3.1 (The EpiData Association, Odense Denmark), while data analyses were performed using SPSS Version 20.0 (IBM Corporation, New York, United States).

RESULTS

Demographics of study participants

Of the 7200 people recruited for the study, 7106 completed the survey. Of these, 50.9% were female (n=3614), and 48.8% lived in urban areas (n=3468). The distribution of age was as follows: 18–29: 20.5% (n=1450); 30–39: 20.1% (n=1424); 40–49: 20.6% (n=1461); 50–59: 19.6% (n=1391); and ≥ 60 years: 19.2% (n=1362). Almost all participants (n=6710, 95.7%) had no

children or one child in their family. Only about a tenth (n=730, 10.3%) of participants reported a low education level (none or primary school). Three in 10 (n=2149, 30.2%) participants reported having a chronic illness, and one-eighth (n=894, 12.6%) had a fever within the past year. Approximately three-fifths (n=4168, 58.7%) reported receiving recommendations from healthcare workers. For all adults, 5793 (81.5%) agreed that the influenza vaccine could prevent infection, and 5958 (83.8%) stated they were aware of the free influenza vaccine policy in Beijing. Approximately three-fifths of participants reported being afraid of catching influenza during an epidemic (n=4320) and fear of side effects (n=4273). Only half felt influenza was a serious disease (n=3720). (Table 1)

Weighted coverage rates of seasonal influenza vaccine

The weighted coverage rate of the seasonal influenza vaccine was 20.6% (95% CI: 19.7–21.5%) among adults in Beijing during the 2014/2015 influenza season. Regarding the difference between age groups, the coverage rates were 48.7% (95% CI: 46.0–51.4%) and 16.0% (95% CI: 14.1–17.9%) in older adults aged ≥60 years and younger adults aged <60 years, respectively.

Univariate analysis of variables affecting seasonal influenza vaccination uptake

Overall, 1610 (22.7%) participants reported having received seasonal influenza vaccine during the previous season (2014/2015). The rates did not differ by sex (P=0.541) or residence (P=0.275). The rate among older adults aged ≥60 years was significantly higher (P<0.001). Rates decreased with increasing education levels, from 43.8% of participants with no or primary school education to 18.7% of those who were 3-year college graduates or higher (P<0.001). The significantly different rates were observed between the two income categories (27.0% vs. 21.0%, P<0.001). Rates decreased with family population, from 28.7% of participants whose family population was one or two people to 21.5% of those whose family population were six or more people (P<0.001). The rates were significantly higher among people with a chronic illness (35.5% vs. 17.1%, P<0.001) or who had a fever in the past year (27.5% vs. 22%, P<0.001). Participants who received recommendations from healthcare workers were more likely to be vaccinated (33.0% vs. 8.0%, P<0.001). Those with awareness of the severity of the disease, susceptibility to the disease, effectiveness of the vaccination, and the free influenza vaccine policy in Beijing were more likely to be vaccinated (P<0.001), while those concerned about side effects of vaccination were less likely (P=0.006). (Table 1)

Table 1 Univariate analysis of variables affecting seasonal influenza vaccination uptake in Beijing during the 2014/2015 influenza season

Variables		Total participants		Vaccinated participants		Unvaccinated participants		P value§
		N	%	n	%*	n	%*	
Sex								
	Male	3484	49.1	778	22.3	2706	77.7	0.541
	Female	3614	50.9	829	22.9	2785	77.1	
	Missing	8		3		5		
Age (years)								
	18–29	1450	20.5	216	14.9	1234	85.1	<0.001
	30–39	1424	20.1	212	14.9	1212	85.1	
	40–49	1461	20.6	203	13.9	1258	86.1	
	50–59	1391	19.6	302	21.7	1089	78.3	
	≥60	1362	19.2	672	49.3	690	50.7	
	Missing	18		5		13		
Highest education								
	primary school or none	730	10.3	320	43.8	410	56.2	<0.001
	junior high school	1850	26.1	418	22.6	1432	77.4	

	senior high school	2167	30.6	422	19.5	1745	80.5	
	3-year college graduate or above	2334	33.0	437	18.7	1897	81.3	
	Missing	25		13		12		
Residence								
	Suburban	3638	51.2	805	22.1	2833	77.9	0.275
	Urban	3468	48.8	805	23.2	2663	76.8	
	Missing	0		0		0		
Monthly income per capita (yuan) ǂ								
	0–2000	1887	27.3	509	27.0	1378	73.0	<0.001
	>2000	5023	72.7	1056	21.0	3967	79.0	
	Missing	196		45		151		
Family population								
	1–2	547	7.7	157	28.7	390	71.3	<0.001
	3	1831	25.8	487	26.6	1344	73.4	
	4	2415	34.0	458	19.0	1957	81.0	
	5	1179	16.6	264	22.4	915	77.6	
	≥6	1130	15.9	243	21.5	887	78.5	
	Missing	4		1		3		
Number of children in the family								
	0	3915	55.8	959	24.5	2956	75.5	<0.001
	1	2795	39.9	548	19.6	2247	80.4	
	≥2	300	4.3	65	21.7	235	78.3	
	Missing	96		38		58		
History of chronic illness								
	Yes	2149	30.2	763	35.5	1386	64.5	<0.001
	No	4957	69.8	847	17.1	4110	82.9	
	Missing	0		0		0		
History of having a fever within the past year								
	Yes	894	12.6	246	27.5	648	72.5	<0.001
	No	6194	87.4	1363	22.0	4831	78.0	
	Missing	18		1		17		
Recommendations from healthcare workers								
	Yes	4168	58.7	1376	33.0	2792	67.0	<0.001
	No	2938	41.3	234	8.0	2704	92.0	
	Missing	0		0		0		
Perceived severity of the disease (influenza is a serious disease)								
	Yes	4328	52.1	1044	24.1	3284	75.9	<0.001
	No	2778	47.9	566	20.4	2212	79.6	
	Missing	0		0		0		
Perceived susceptibility to the								

disease (I am afraid of catching influenza during an epidemic)								
	Yes	4320	60.8	1055	24.4	3265	75.6	<0.001
	No	2786	39.2	555	19.9	2231	80.1	
	Missing	0		0		0		
Perceived effectiveness of vaccination (the vaccine can prevent influenza infection)								
	Yes	5793	81.5	1432	24.7	4361	75.3	<0.001
	No	1313	18.5	178	13.6	1135	86.4	
	Missing	0		0		0		
Perceived side effects of vaccination (I am scared of the vaccine's side effects)								
	Yes	4273	60.1	921	21.6	3352	78.4	0.006
	No	2833	39.9	689	24.3	2144	75.7	
	Missing	0		0		0		
Awareness of the free influenza vaccine policy in Beijing								
	Yes	5958	83.8	1483	24.9	4475	75.1	<0.001
	No	1148	16.2	127	11.1	1021	88.9	
	Missing	0		0		0		

Note: "Missing" indicates the number of people who did not answer this question.
＊%=n/N×100%.
§Pearson's chi-square test.
ǂUS$100=680 yuan.

Multiple logistic regression analysis for the factors associated with seasonal influenza vaccination uptake

As shown in Table 2, the factors associated with seasonal influenza vaccination uptake were: being aged ≥60 years (OR 3.3; 95% CI: 2.8–3.9), lower education (OR 1.8; 95% CI: 1.5–2.2), living in urban areas (OR 1.3; 95% CI: 1.1–1.5), having a chronic illness (OR 1.5; 95% CI: 1.3–1.8), having a fever within the past year (OR 1.4; 95% CI: 1.1–1.7), recommendations from healthcare workers (OR 4.5; 95% CI: 3.8–5.3), perceived susceptibility to the disease (OR 1.2; 95% CI: 1.0–1.4), perceived effectiveness of vaccination (OR 1.8; 95% CI: 1.5–2.2), perceived side effects of vaccination (OR 0.7; 95% CI: 0.6–0.8) and awareness of the free influenza vaccine policy in Beijing (OR 1.3; 95% CI: 1.1–1.7).

For older adults, the factors associated with seasonal influenza vaccination uptake were lower education (OR 1.6; 95% CI: 1.2–2.1), having a chronic illness (OR 1.9; 95% CI: 1.5–2.4), recommendations from healthcare workers (OR 5.4; 95% CI: 3.9–7.4), perceived susceptibility to the disease (OR 1.5; 95% CI: 1.2–2.0), perceived side effects of vaccination (OR 0.6; 95% CI: 0.4–0.7) and awareness of the free influenza vaccine policy in Beijing (OR: 1.9; 95% CI 1.2–2.9). For younger adults, the factors affecting uptake were lower education (OR 1.9; 95% CI: 1.4–2.6), living in urban areas (OR 1.4; 95% CI: 1.2–1.6), having a chronic illness (OR 1.4; 95% CI: 1.2–1.7), having a fever within the past year (OR 1.4; 95% CI: 1.1–1.8), recommendations from healthcare workers (OR 4.5; 95% CI: 3.7–5.4), perceived effectiveness of vaccination (OR 2.2; 95% CI: 1.7–2.8) and perceived side effects of vaccination (OR 0.8; 95% CI: 0.7–1.0). (Table 2)

Table 2 Multiple logistic regression analysis for the factors associated with seasonal influenza vaccination uptake in Beijing during the 2014/2015 influenza season

Variables	All adults (N=7106)		Older adults (Age≥60) (N=1362)		Younger adults (Age=18–59) (N=5726)	
	Vaccinated %(n/N)	Adjusted OR(95%CI) §	Vaccinated %(n/N)	Adjusted OR(95%CI) §	Vaccinated %(n/N)	Adjusted OR(95%CI) §
Sex						
Male	22.3(778/3484)	NS	49.9(342/685)	NS	15.5(433/2788)	NS
Female	22.9(829/3614)		48.7(328/674)		17.0(499/2933)	
Age (years)						
18–59	16.3(933/5726)	1.0(referent)	–		16.3(933/5726)	
≥60	49.3(672/1362)	3.3(2.8-3.9)	49.3(672/1362)		–	
Highest education						
primary school or none	43.8(320/730)	1.8(1.5-2.2)	58.3(246/422)	1.6(1.2-2.1)	24.1(74/307)	1.9(1.4-2.6)
junior high school or above	22.6(1277/6351)	1.0(referent)	45.1(419/929)	1.0(referent)	15.8(853/5405)	1.0(referent)
Residence						
Suburban	22.1(805/3638)	1.0(referent)	51.1(365/714)	NS	15.0(438/2919)	1.0(referent)
Urban	23.2(805/3468)	1.3(1.1-1.5)	47.4(307/648)		17.6(495/2807)	1.4(1.2-1.6)
Monthly income per capita (yuan) ǂ						
0-2000	27.0(509/1887)	NS	54.8(276/504)	NS	16.8(231/1378)	NS
>2000	21.0(1056/5023)		46.5(384/825)		16.0(669/4186)	
Family population						
1-2	28.7(157/547)	NS	53.7(95/177)	NS	16.8(62/368)	NS
3	26.6(487/1831)		50.2(256/510)		17.4(229/1314)	
4	19.0(458/2415)		42.2(89/211)		16.7(368/2203)	
5	22.4(264/1179)		55.0(110/200)		15.7(153/974)	
≥6	21.5(243/1130)		46.2(121/262)		14.0(121/865)	
Number of children in the family						
0	24.5(959/3915)	NS	51.2(460/899)	NS	16.6(498/3008)	NS
1	19.6(548/2795)		44.1(171/388)		15.6(375/2398)	
≥2	21.7(65/300)		53.2(25/47)		15.9(40/252)	
History of chronic illness						
Yes	35.5(763/2149)	1.5(1.3-1.8)	54.3(490/902)	1.9(1.5-2.4)	21.9(271/1239)	1.4(1.2-1.7)
No	17.1(847/4957)	1.0(referent)	39.6(182/460)	1.0(referent)	14.8(662/4487)	1.0(referent)
History of having a fever within the past year						
Yes	27.5(246/894)	1.4(1.1-1.7)	54.8(103/188)	NS	20.4(143/702)	1.4(1.1-1.8)
No	22.0(1363/6194)	1.0(referent)	48.5(568/1170)		15.8(790/5010)	1.0(referent)
Recommendations from healthcare workers						
Yes	33.0(1376/4168)	4.5(3.8-5.3)	59.6(594/996)	5.4(3.9-7.4)	24.6(777/3160)	4.5(3.7-5.4)
No	8.0(234/2938)	1.0(referent)	21.3(78/366)	1.0(referent)	6.1(156/2566)	1.0(referent)

Perceived severity of the disease (influenza is a serious disease)						
Yes	24.1(1044/4328)	NS	48.5(452/931)	NS	17.4(590/3390)	NS
No	20.4(566/2778)		51.0(220/431)		14.7(343/2336)	
Perceived susceptibility to the disease (I am afraid of catching influenza during an epidemic)						
Yes	24.4(1055/4320)	1.2(1-1.4)	52.8(443/839)	1.5(1.2-2)	17.6(609/3469)	NS
No	19.9(555/2786)	1.0(referent)	43.8(229/523)	1.0(referent)	14.4(324/2257)	
Perceived effectiveness of vaccination (the vaccine can prevent influenza infection)						
Yes	24.7(1432/5793)	1.8(1.5-2.2)	51.7(582/1125)	NS	18.2(847/4656)	2.2(1.6-2.8)
No	13.6(178/1313)	1.0(referent)	38.0(90/237)		8.0(86/1070)	1.0(referent)
Perceived side effects of vaccination (I am scared of the vaccine's side effects)						
Yes	21.6(921/4273)	0.7(0.6-0.8)	46.5(342/736)	0.6(0.4-0.7)	16.3(576/3525)	0.8(0.7-1)
No	24.3(689/2833)	1.0(referent)	52.7(330/626)	1.0(referent)	16.2(357/2201)	1.0(referent)
Awareness of the free influenza vaccine policy in Beijing						
Yes	24.9(1483/5958)	1.3(1.1-1.7)	53.0(629/1186)	1.9(1.2-2.9)	17.9(849/4755)	NS
No	11.1(127/1148)	1.0(referent)	24.4(43/176)	1.0(referent)	8.7(84/971)	

Note: The sum of the two age groups was not equal to the sample size of all adults because 18 participants did not answer the question regarding age.
OR= odds ratio; 95% CI=95% confidence interval.
NS: Not significant.
§Multiple logistic regression analysis.
ǂUS$100=680 yuan.

Comparison between age groups regarding disease history, recommendations from healthcare workers and public perceptions

Pearson's chi-square tests indicated that older adults aged ≥60 years were more likely to receive recommendations from healthcare workers (73.1% vs. 55.2%, P<0.001), have a chronic illness (66.2% vs. 22.1%, P<0.001), perceive severity of the disease (55.9% vs. 51.2%, P=0.002) and be aware of the free influenza vaccine policy in Beijing (87.1% vs. 83.0%, P<0.001). They were less likely to be concerned about side effects of the vaccination (54.0% vs. 61.6%, P<0.001). For both older and younger adults, compared with more highly educated participants, lower-educated participants with primary school education or below were less likely to report fear of side effects (older adults: 46.2% vs. 57.6%, P<0.001; younger adults: 54.4% vs. 62.0%, P<0.001) and that the influenza vaccine could prevent infection (older adults: 78.9% vs. 84.1%, P=0.021; younger adults: 75.6% vs. 81.7%, P=0.007), whereas they were more likely to report influenza was a serious disease (older adults: 73.2% vs. 65.9%, P=0.007; younger adults: 73.6% vs. 58.4%, P<0.001). Moreover, lower-educated older adults reported receiving recommendations from healthcare workers more frequently than more highly educated participants (77.5% vs. 70.9%, P=0.012). For younger adults, lower-educated participants were more likely to have a chronic illness (39.4% vs. 20.7%, P<0.001).

DISCUSSION

In this study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in the general population of Beijing. The survey showed vaccination coverage rates in the general population of Beijing were 20.6% during the 2014/2015 influenza season, which was nearly the same as in certain European countries [16] (25.0% in the United Kingdom, 27.4% in Germany, 21.8% in Spain, 24.2% in France, and 24.4% in Italy), but much lower than in the United States [17] (39.7% in 2014/2015). In Beijing, the coverage rate during the 2014/2015 season was consistent with that of 2009/2010 (21.8%), but higher than that of 2008/2009 and 2010/2011 (16.9% and 16.7%, respectively) [11], and an increase in coverage was observed after 2010/2011. Since 2007, free influenza vaccines have been provided to adults aged ≥60 years and students in primary and middle schools in Beijing. Meanwhile, influenza immunization campaigns are conducted each year. Immunization activities including health education and promotion and better access to vaccination may increase coverage of the influenza vaccine in Beijing [18].

The present study showed older adults were more likely to be vaccinated than younger adults. Two reasons may contribute to this. First, the free vaccination policy was a key factor. The Beijing Government has provided free annual seasonal influenza vaccination to older adults since 2007, and the vaccine coverage rate for this subpopulation increased substantially from 1.7% during 1999–2004 [19] to 48.7% in the 2014/2015 season. In most regions of China, older adults must pay out of pocket for the seasonal influenza vaccine, which contributed to a very low coverage rate of 1.5–2.2% between 2004 and 2014 [8]. However, coverage of the influenza vaccine in older adults in Beijing was much lower than that in five Western-European countries (61.1%) [16] and the United States (61.3%) [17], and failed to meet the World Health Organization's target of 75% coverage in 2010 [16]. Second, we found older adults were more likely to receive recommendations from healthcare professionals and to perceive the severity of seasonal influenza. They were also less likely to be concerned about side effects of the vaccine. These factors may have led to increased uptake.

Recommendations from healthcare workers were the most important factor affecting influenza vaccination uptake in both older and younger adults; previous studies also showed this result [20-21]. Although healthcare workers are the foremost roles who can encourage people to be vaccinated, the vaccination coverage among healthcare workers themselves in Beijing was low. A previous study found only a quarter of healthcare workers received the vaccine against pandemic influenza in the 2009/2010 season, 60% were concerned about side effects, and half had doubts about the vaccine's effectiveness [22]. Therefore, health promotion activities should be conducted not only for the general population but also for healthcare professionals. More measures should also be taken to motivate these workers to recommend influenza vaccination.

Consistent with two recent meta-analyses [13,23], the present study documented that public perceptions including concerns about susceptibility to influenza, doubts about the vaccine's effectiveness, and fears of side effects can influence the vaccine uptake. Age-related differences were found in perceived susceptibility to influenza and awareness of the free influenza vaccine policy being risk factors for older adults, perceived effectiveness of vaccination for younger adults, and perceived side effects of vaccination for both. In the present study, two-fifths did not report fear of catching influenza, 18.5% did not report the influenza vaccine could prevent infection, and 60% reported fear of side effects. The results indicated that accurate information about the severity of the disease, susceptibility to influenza, and vaccine effectiveness and side effects should be conveyed to the public when holding vaccination campaigns in Beijing.

Higher educational attainment is usually considered positively associated with vaccination uptake [24]. Conversely, we found that lower levels of education had a positive impact on vaccination uptake; a result consistent with our previous study [11]. In this study, multiple logistic regression analysis by age showed lower education was a risk factor for vaccination in both older and younger adults, and income was not. In other words, influenza vaccination was significantly influenced by educational attainment, independent of age and income. Several reasons may contribute to the higher coverage rate among lower-educated people. First, in recent years, media broadcasts and internet discussions targeting vaccine-related adverse outcomes have brought public suspicion in China about influenza vaccination [25]. Lower-educated people are less likely

to be exposed to such information [11], and this may have a positive effect on vaccination. Our results, which supported this assumption, showed for both younger and older adults, lower-educated people were less likely to report fear of side effects, but more likely to report viewing influenza as a serious disease. Second, this study found lower-educated older adults more frequently reported receiving recommendations from healthcare workers than did those with higher levels of education. Third, for younger adults, lower-educated people were more likely to have a chronic illness, which was a risk factor for vaccination in this study.

This study found suffering from a fever or chronic illness was associated with greater intent to be vaccinated. That finding was consistent with Blank's study, and could be explained by heightened perceptions of personal risk [26]. We also found younger adults living in urban areas were more likely to receive the vaccine than those from suburban areas, and better access to vaccines may be the main reason for their intent to be vaccinated.

Strengths of this study are its large sample size of 7206 participants and its high response rate of 98.7%, implying the findings are highly representative and reliable. However, there are some limitations in this study. First, considering diversity of income levels and healthcare access across regions, our observations may not be effectively generalizable for other countries or regions. Additionally, because all the information was collected via a self-reported questionnaire, the investigators could not check the accuracy of responses, which may have led to reporting bias. Also, the respondents had to recall their experiences with vaccination; therefore, recall bias cannot be ruled out. Finally, the causal relationships could not be established because of the cross-sectional design.

CONCLUSIONS

This study demonstrated that the overall coverage rate of the influenza vaccine was 20.6% among adults in Beijing during the 2014/2015 influenza season. Recommendations from healthcare professionals, perceived susceptibility to the disease, perceived effectiveness of vaccination, and awareness of the free influenza vaccine policy in Beijing were positively associated with vaccine uptake. Perceived side effects of vaccination had a negative impact. A great number of Beijing residents feared the side effects, had doubts about the vaccine's effectiveness, were not concerned about susceptibility to influenza, and did not receive healthcare workers' recommendations to get vaccinated. Vaccination campaigns that target increasing professional recommendations and public perceptions need to be implemented in the coming years.

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AUTHORS' CONTRIBUTIONS

SW, JS, PY and QW conceived of the study and participated in its design. SW, JS, HZ, HL, YC, WH, CL and YT collected the data. SW and JS analyzed the data. All authors helped to draft the manuscript and have read and approved the final manuscript.

COMPETIING INTERESTS

The authors declare that they have no competing interests.

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DATA SHARING STATEMENT

Other data can be requested by emailing the corresponding author.

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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	This study is not a cohort or case-control study.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	As a population based survey, the results of this study are clear. In my view, there is no need to describe any sensitivity analyses.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	The study is a population based survey and the study design is simple. Thus, there is no need to use a flow diagram.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	6-8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	This study is not a cohort study.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	This study is not a cohort study.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	This study is not a *case-control study.*
		Cross-sectional study—Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-10
		(*b*) Report category boundaries when continuous variables were categorized	6-10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-10

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China

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Factors associated with the uptake of seasonal influenza vaccination in older and younger adults: a large, population-based survey in Beijing, China

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ABSTRACT

Objectives

The present study aimed to estimate the influenza vaccination coverage rate in Beijing, China, and identify its determinants in older and younger adults.

Methods

A survey was conducted among Chinese adults using a self-administered, anonymous questionnaire in May–June, 2015. The main outcome was seasonal influenza vaccination uptake. Multivariate logistic regression models were performed to identify factors associated with uptake.

Results

A total of 7106 participants completed the questionnaire. The overall coverage rate was 20.6% (95% confidence interval [CI]: 19.7–21.5%) in the 2014/2015 influenza season. Lower education (older adults: OR 1.6; 95% CI: 1.2–2.1; younger adults: OR 1.9; 95% CI: 1.4-2.6), having a chronic illness (older adults: OR 1.9; 95% CI: 1.5–2.4; younger adults: OR 1.4; 95% CI: 1.2–1.7) and recommendations from healthcare workers (older adults: OR 5.4; 95% CI: 3.9–7.4; younger adults: OR 4.5; 95% CI: 3.7–5.4) were positively associated with uptake; perceived side effects of vaccination had a negative impact (older adults: OR 0.6; 95% CI: 0.4–0.7; younger adults: OR 0.8; 95% CI: 0.7–1.0). Perceived susceptibility to influenza (OR 1.5; 95% CI: 1.2–2.0) and awareness of the free influenza vaccine policy (OR: 1.9; 95% CI 1.2–2.9) were only associated with vaccine uptake in older adults, while perceived effectiveness of vaccination (OR 2.2; 95% CI: 1.7–2.8) was only a predictor for younger adults. Older adults were more likely to receive recommendations from healthcare professionals and perceive the severity of seasonal influenza, and less likely to worry about side effects of vaccination.

Conclusions

The influenza vaccination coverage rate was relatively low in Beijing. Apart from free vaccinations for older adults, age disparity in the rate between older and younger adults (48.7% vs. 16.0%) may be explained by differing professional recommendations and public perceptions. Vaccination campaigns targeting increasing professional recommendations and public perceptions should be implemented in the coming years.

Key words

Influenza vaccine, Vaccination, Coverage, Factors, Adult

Strengths and limitations of this study:

Strengths of this study were the large sample size of 7106 participants and high response rate of 98.7%, indicating high representation and reliability in the findings.

Self-reported influenza vaccination uptake may result in recall bias.

The causal relationships could not be established because of the cross-sectional design.

INTRODUCTION

Seasonal influenza is a weighty public health problem that causes substantial mortality and morbidity, especially among older people and others with high-risk conditions [1]. Worldwide, annual epidemics are estimated to result in about three to five million cases of severe illness and 250,000–500,000 deaths [2]. Vaccination is an effective way to minimize influenza-related mortality and morbidity [3-5]; many public health organizations, including the China Centers for Disease Prevention and Control, have recommended all people over 6 months old, particularly those at high risk, receive the influenza vaccine annually [6]. Although seasonal vaccination has been recommended for many years, a global study of seasonal influenza vaccine dose distribution found that coverage remains low in many countries, especially low- and middle-income countries [7]. People in most regions of China bear the full cost of the vaccine; this led to the very low 1.5–2.2% coverage rate between 2004 and 2014 [8].

The Chinese capital of Beijing has a population of about 20 million. Abundant and convenient transportation and high population density make the city an easily affected host for both seasonal and pandemic influenza [9]. Since 2007, the Beijing Government, ahead of governments in most cities in China, has provided free influenza vaccines to people aged ≥60 years, and for students in primary or middle schools, between September and November of each year. Available data show the policy greatly increased the vaccine uptake rate in the qualifying population [10]. Therefore, Beijing's experience can serve to inform future government-funded reimbursement policies for seasonal influenza vaccination in other regions of China, as well as in other developing countries.

Our previous study in Beijing estimated the influenza vaccination coverage rate of the general population at 16.7% in 2008/2009, 16.9% in 2010/2011 and 21.8% during the 2009 pandemic. The rates were much higher than in other regions of China, yet lower than those of Western countries [11]. Coverage was much higher among older adults than younger adults in Beijing in 2010, but lower than that among older adults in other countries with similar policies [12]. The influencing factors associated with uptake of the influenza vaccine need to be determined in order to improve coverage. Meanwhile, previous studies in Beijing only determined demographics factors for uptake [11]. Apart from a free vaccination policy and demographics, many other factors, including perceptions of personal risk, disease severity, effectiveness and side effects of vaccination, and the related impact of healthcare workers may also affect uptake [13-14].

In the present study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in Beijing's general population. The study aimed to: (1) estimate coverage rates among older adults aged ≥60 years and younger adults aged <60 years in the 2014/2015 influenza season; (2) identify the factors–including demographics factors, public perceptions and impact of healthcare workers–associated with uptake; and (3) find the reasons for age-related differences in the coverage rate between younger and older adults.

METHODS

Study participants

This study employed a population-based survey in the Beijing metropolitan area. The target population was Chinese adults living in Beijing for longer than half a year. The function $n = \mu_\alpha^2 \times \pi \times (1-\pi) / \delta^2 \times$ deff was used to calculate the sample size of each subgroup. We estimated a sample size of 576 participants per subgroup, based on μ_α=1.96, influenza vaccination rate (π) =50%, maximum permissible error (δ) =0.1π, and design effect of complex sampling (deff) = 1.5. Considering area of residence (urban or suburban), and different age groups (18–29, 30–39, 40–49, 50–59 and ≥60 years), and a no-response rate of 25%, the optimal sample size for the present study was 7200 (576 participants per subgroup × 10 subgroups × 1.25). Participants were randomly selected from 150 survey locations that were the same as in the previous study [11]. All adults in each survey location were numbered, and then 48 were randomly selected to meet the sample size requirement.

Data collection

The survey was conducted using a self-administered, anonymous questionnaire in May–June, 2015. The questionnaire was in Chinese and consisted of five sections: receiving seasonal influenza vaccine in the 2014/2015 influenza season, having a fever within the past year, recommendations from healthcare workers, public perceptions toward influenza and its vaccine, and demographics. (1) History of receiving the vaccine was assessed using the yes/no question: "Did you receive the seasonal influenza vaccine during the previous season (2014/2015)?" (2) Recommendations from healthcare workers were assessed using: "Did healthcare workers recommend the seasonal influenza vaccine to you during the previous season (2014/2015)?" (3) History of having a fever within the past year was assessed using: "Have you had a fever within the past year?" (4) To assess public perceptions toward influenza and its vaccine, the following yes/no questions were asked: "Do you think influenza is a serious disease?", "Are you afraid of catching influenza during an epidemic?", "Do you think the vaccine can prevent influenza infection?", "Are you scared of the vaccine's side effects?", and "Do you know about the free influenza vaccine policy in Beijing?". (5) Regarding demographics information, the participants were asked to report their sex (female or male), age (continuous), highest educational attainment (primary school or none, junior high school, senior high school, 3-year college graduate or above), residence (urban or suburban), monthly income per capita (0–2000 or >2000 yuans; US$100 is equivalent to approximately 680 yuan), family population which refers to the number of people living in the home (continuous), number of children in the family (continuous) and history of chronic illness (yes or no). The average monthly income of Beijing residents was 3659 and 1685 yuan in urban and suburban areas respectively. All questions were developed based on measures adapted from our previous study and from the existing literature [11,13-14].

Local healthcare workers performed all interviews. Before each questionnaire was distributed, all investigators were required to explain to respondents the purpose, procedures and confidentiality agreement for the study, and written informed consent was accordingly obtained. In most cases, the participants completed the questionnaires independently. The investigators read and explained the questionnaires to candidates who were unable to sufficiently understand them.

Ethics statement

This study was approved by the Institutional Review Board and Human Research Ethics Committee of the Beijing Center for Disease Prevention and Control. Anonymity of participants was guaranteed, and informed consent was required for performing the surveys.

Statistical analysis

The main outcome was seasonal influenza vaccination uptake in the 2014/2015 influenza season. Descriptive analysis was performed to generate frequency distributions of the survey variables, and differences between the subgroups were tested using Pearson's chi-square test. The tables list the numbers of participants for whom missing data were reported. Weighted analysis was conducted to calculate weighted coverage rates, accounting for age, sex, and residence of those in the Beijing population, as reported in the 2010 Census of Beijing [15]. Multivariate logistic regression models were performed to examine the factors associated with uptake of the vaccine, and the odds ratio (OR) and 95% confidence intervals (95% CI) were used as measures of association. All statistical tests were two-sided, with $P<0.05$ considered statistically significant. Data entry was performed using Epidata software Version 3.1 (The EpiData Association, Odense Denmark), while data analyses were performed using SPSS Version 20.0 (IBM Corporation, New York, United States).

RESULTS

Demographics of study participants

Of the 7200 people recruited for the study, 7106 completed the survey. The characteristics of the participants were presented in Table 1. Of these, 50.9% were female (n=3614), and 48.8% lived in urban areas (n=3468). The distribution of age was as follows: 18–29: 20.5% (n=1450); 30–39: 20.1% (n=1424); 40–49: 20.6% (n=1461); 50–59: 19.6% (n=1391); and ≥ 60 years: 19.2%

(n=1362).

Weighted coverage rates of seasonal influenza vaccine

The weighted coverage rate of the seasonal influenza vaccine was 20.6% (95% CI: 19.7–21.5%) among adults in Beijing during the 2014/2015 influenza season. Regarding the difference between age groups, the coverage rates were 48.7% (95% CI: 46.0–51.4%) and 16.0% (95% CI: 14.1–17.9%) in older adults aged ≥60 years and younger adults aged <60 years, respectively.

Univariate analysis of variables affecting seasonal influenza vaccination uptake

Overall, 1610 (22.7%) participants reported having received seasonal influenza vaccine during the previous season (2014/2015). The rates did not differ by sex (P=0.541) or residence (P=0.275). The rate among older adults aged ≥60 years was significantly higher (P<0.001). Rates decreased with increasing education levels, from 43.8% of participants with no or primary school education to 18.7% of those who were 3-year college graduates or higher (P<0.001). The significantly different rates were observed between the two income categories (27.0% vs. 21.0%, P<0.001). Rates decreased with family population, from 28.7% of participants whose family population was one or two people to 21.5% of those whose family population were six or more people (P<0.001). The rates were significantly higher among people with a chronic illness (35.5% vs. 17.1%, P<0.001) or who had a fever in the past year (27.5% vs. 22%, P<0.001). Participants who received recommendations from healthcare workers were more likely to be vaccinated (33.0% vs. 8.0%, P<0.001). Those with awareness of the severity of the disease, susceptibility to the disease, effectiveness of the vaccination, and the free influenza vaccine policy in Beijing were more likely to be vaccinated (P<0.001), while those concerned about side effects of vaccination were less likely (P=0.006). (Table 1)

Table 1 Univariate analysis of variables affecting seasonal influenza vaccination uptake in Beijing during the 2014/2015 influenza season

Variables		Total participants	Vaccinated participants		Unvaccinated participants		P value§
		N	n	%*	n	%*	
Sex							
	Male	3484	778	22.3	2706	77.7	0.541
	Female	3614	829	22.9	2785	77.1	
	Missing	8	3		5		
Age (years)							
	18–29	1450	216	14.9	1234	85.1	<0.001
	30–39	1424	212	14.9	1212	85.1	
	40–49	1461	203	13.9	1258	86.1	
	50–59	1391	302	21.7	1089	78.3	
	≥60	1362	672	49.3	690	50.7	
	Missing	18	5		13		
Highest education							
	primary school or none	730	320	43.8	410	56.2	<0.001
	junior high school	1850	418	22.6	1432	77.4	
	senior high school	2167	422	19.5	1745	80.5	
	3-year college graduate or	2334	437	18.7	1897	81.3	

	above						
	Missing	25	13		12		
Residence							
	Suburban	3638	805	22.1	2833	77.9	0.275
	Urban	3468	805	23.2	2663	76.8	
	Missing	0	0		0		
Monthly income per capita (yuan) ǂ							
	0–2000	1887	509	27.0	1378	73.0	<0.001
	>2000	5023	1056	21.0	3967	79.0	
	Missing	196	45		151		
Family population							
	1–2	547	157	28.7	390	71.3	<0.001
	3	1831	487	26.6	1344	73.4	
	4	2415	458	19.0	1957	81.0	
	5	1179	264	22.4	915	77.6	
	≥6	1130	243	21.5	887	78.5	
	Missing	4	1		3		
Number of children in the family							
	0	3915	959	24.5	2956	75.5	<0.001
	1	2795	548	19.6	2247	80.4	
	≥2	300	65	21.7	235	78.3	
	Missing	96	38		58		
History of chronic illness							
	Yes	2149	763	35.5	1386	64.5	<0.001
	No	4957	847	17.1	4110	82.9	
	Missing	0	0		0		
History of having a fever within the past year							
	Yes	894	246	27.5	648	72.5	<0.001
	No	6194	1363	22.0	4831	78.0	
	Missing	18	1		17		
Recommendations from healthcare workers							
	Yes	4168	1376	33.0	2792	67.0	<0.001
	No	2938	234	8.0	2704	92.0	
	Missing	0	0		0		
Perceived severity of the disease (influenza is a serious disease)							
	Yes	4328	1044	24.1	3284	75.9	<0.001
	No	2778	566	20.4	2212	79.6	
	Missing	0	0		0		
Perceived susceptibility to the disease (I am afraid of catching influenza during an epidemic)							

	Yes	4320	1055	24.4	3265	75.6	<0.001
	No	2786	555	19.9	2231	80.1	
	Missing	0	0		0		
Perceived effectiveness of vaccination (the vaccine can prevent influenza infection)							
	Yes	5793	1432	24.7	4361	75.3	<0.001
	No	1313	178	13.6	1135	86.4	
	Missing	0	0		0		
Perceived side effects of vaccination (I am scared of the vaccine's side effects)							
	Yes	4273	921	21.6	3352	78.4	0.006
	No	2833	689	24.3	2144	75.7	
	Missing	0	0		0		
Awareness of the free influenza vaccine policy in Beijing							
	Yes	5958	1483	24.9	4475	75.1	<0.001
	No	1148	127	11.1	1021	88.9	
	Missing	0	0		0		

Note: "Missing" indicates the number of people who did not answer this question.
＊%=n/N×100%.
§Pearson's chi-square test.
ǂUS$100=680 yuan.

Multiple logistic regression analysis for the factors associated with seasonal influenza vaccination uptake

As shown in Table 2, the results of multiple logistic regression analysis indicated that lower education (older adults: OR 1.6; 95% CI: 1.2–2.1; younger adults: OR 1.9; 95% CI: 1.4-2.6), having a chronic illness (older adults: OR 1.9; 95% CI: 1.5–2.4; younger adults: OR 1.4; 95% CI: 1.2–1.7) and recommendations from healthcare workers (older adults: OR 5.4; 95% CI: 3.9–7.4; younger adults: OR 4.5; 95% CI: 3.7–5.4) were positively associated with influenza vaccination uptake; perceived side effects of vaccination had a negative impact (older adults: OR 0.6; 95% CI: 0.4–0.7; younger adults: OR 0.8; 95% CI: 0.7–1.0). Regarding age-related differences, perceived susceptibility to influenza (OR 1.5; 95% CI: 1.2–2.0) and awareness of the free influenza vaccine policy (OR: 1.9; 95% CI 1.2–2.9) were only associated with vaccine uptake in older adults, while perceived effectiveness of vaccination (OR 2.2; 95% CI: 1.7–2.8) was only a predictor for younger adults.

Table 2 Multiple logistic regression analysis for the factors associated with seasonal influenza vaccination uptake in Beijing during the 2014/2015 influenza season

Variables	All adults (N=7106)			Older adults (Age≥60) (N=1362)			Younger adults (Age=18–59) (N=5726)		
	N	Vaccinated %	Adjusted OR(95%CI) §	N	Vaccinated %	Adjusted OR(95%CI) §	N	Vaccinated %	Adjusted OR(95%CI) §
Age (years)									
18–59	5726	16.3	1.0(referent)						

≥60	1362	49.3	3.3(2.8-3.9)						
Highest education									
primary school or none	730	43.8	1.8(1.5-2.2)	422	58.3	1.6(1.2-2.1)	307	24.1	1.9(1.4-2.6)
junior high school or above	6351	22.6	1.0(referent)	929	45.1	1.0(referent)	5405	15.8	1.0(referent)
Residence									
Suburban	3638	22.1	1.0(referent)	714	51.1	1.0(referent)	2919	15	1.0(referent)
Urban	3468	23.2	1.3(1.1-1.5)	648	47.4	1.0(0.8-1.3)*	2807	17.6	1.4(1.2-1.6)
History of chronic illness									
Yes	2149	35.5	1.5(1.3-1.8)	902	54.3	1.9(1.5-2.4)	1239	21.9	1.4(1.2-1.7)
No	4957	17.1	1.0(referent)	460	39.6	1.0(referent)	4487	14.8	1.0(referent)
History of having a fever within the past year									
Yes	894	27.5	1.4(1.1-1.7)	188	54.8	1.3(0.9-1.8)*	702	20.4	1.4(1.1-1.8)
No	6194	22	1.0(referent)	1170	48.5	1.0(referent)	5010	15.8	1.0(referent)
Recommendations from healthcare workers									
Yes	4168	33	4.5(3.8-5.3)	996	59.6	5.4(3.9-7.4)	3160	24.6	4.5(3.7-5.4)
No	2938	8	1.0(referent)	366	21.3	1.0(referent)	2566	6.1	1.0(referent)
Perceived susceptibility to the disease (I am afraid of catching influenza during an epidemic)									
Yes	4320	24.4	1.2(1-1.4)	839	52.8	1.5(1.2-2)	3469	17.6	1.1(0.9-1.3)*
No	2786	19.9	1.0(referent)	523	43.8	1.0(referent)	2257	14.4	1.0(referent)
Perceived effectiveness of vaccination (the vaccine can prevent influenza infection)									
Yes	5793	24.7	1.8(1.5-2.2)	1125	51.7	1.3(1.0-1.9)*	4656	18.2	2.2(1.7-2.8)
No	1313	13.6	1.0(referent)	237	38	1.0(referent)	1070	8	1.0(referent)
Perceived side effects of vaccination (I am scared of the vaccine's side effects)									
Yes	4273	21.6	0.7(0.6-0.8)	736	46.5	0.6(0.4-0.7)	3525	16.3	0.8(0.7-1)
No	2833	24.3	1.0(referent)	626	52.7	1.0(referent)	2201	16.2	1.0(referent)
Awareness of the free influenza vaccine policy in Beijing									
Yes	5958	24.9	1.3(1.1-1.7)	1186	53	1.9(1.2-2.9)	4755	17.9	1.2(0.9-1.6)*
No	1148	11.1	1.0(referent)	176	24.4	1.0(referent)	971	8.7	1.0(referent)

Note: The sum of the two age groups was not equal to the sample size of all adults because 18 participants did not answer the question regarding age.
OR= odds ratio; 95% CI=95% confidence interval.
* P>0.05, not significant.
§In the multiple logistic regression analysis, the following variables were not significantly associated with seasonal influenza vaccination uptake (P>0.05): sex, monthly income per capita, family population, number of children in the family and perceived severity of the disease.

Comparison between age groups regarding disease history, recommendations from

healthcare workers and public perceptions

Pearson's chi-square tests indicated that older adults aged ≥60 years were more likely to receive recommendations from healthcare workers (73.1% vs. 55.2%, P<0.001), have a chronic illness (66.2% vs. 22.1%, P<0.001), perceive severity of the disease (55.9% vs. 51.2%, P=0.002) and be aware of the free influenza vaccine policy in Beijing (87.1% vs. 83.0%, P<0.001). They were less likely to be concerned about side effects of the vaccination (54.0% vs. 61.6%, P<0.001). For both older and younger adults, compared with more highly educated participants, lower-educated participants with primary school education or below were less likely to report fear of side effects (older adults: 46.2% vs. 57.6%, P<0.001; younger adults: 54.4% vs. 62.0%, P<0.001) and that the influenza vaccine could prevent infection (older adults: 78.9% vs. 84.1%, P=0.021; younger adults: 75.6% vs. 81.7%, P=0.007), whereas they were more likely to report influenza was a serious disease (older adults: 73.2% vs. 65.9%, P=0.007; younger adults: 73.6% vs. 58.4%, P<0.001). Moreover, lower-educated older adults reported receiving recommendations from healthcare workers more frequently than more highly educated participants (77.5% vs. 70.9%, P=0.012). For younger adults, lower-educated participants were more likely to have a chronic illness (39.4% vs. 20.7%, P<0.001).

DISCUSSION

In this study, we performed a population-based survey for ongoing assessment of influenza vaccination uptake in the general population of Beijing. The survey showed vaccination coverage rates in the general population of Beijing were 20.6% during the 2014/2015 influenza season, which was nearly the same as in certain European countries [16] (25.0% in the United Kingdom, 27.4% in Germany, 21.8% in Spain, 24.2% in France, and 24.4% in Italy), but much lower than in the United States [17] (39.7% in 2014/2015). In Beijing, the coverage rate during the 2014/2015 season was consistent with that of 2009/2010 (21.8%), but higher than that of 2008/2009 and 2010/2011 (16.9% and 16.7%, respectively) [11], and an increase in coverage was observed after 2010/2011. In Beijing, influenza immunization campaigns are conducted each year. Immunization activities including health education and promotion and better access to vaccination may increase coverage of the influenza vaccine in Beijing [18].

The present study showed older adults were more likely to be vaccinated than younger adults. The following reasons may contribute to this. First, the free vaccination policy was a key factor. The Beijing Government has provided free annual seasonal influenza vaccination to older adults since 2007, and the vaccine coverage rate for this subpopulation increased substantially from 1.7% during 1999–2004 [19] to 48.7% in the 2014/2015 season. In most regions of China, older adults must pay out of pocket for the seasonal influenza vaccine, which contributed to a very low coverage rate of 1.5–2.2% between 2004 and 2014 [8]. However, coverage of the influenza vaccine in older adults in Beijing was much lower than that in five Western-European countries (61.1%) [16] and the United States (61.3%) [17], and failed to meet the World Health Organization's target of 75% coverage in 2010 [16]. Second, we found older adults were more likely to have a chronic illness than younger ones, while having a chronic illness was positively associated with influenza vaccination uptake in both age groups. This may partly explain the higher vaccination coverage in older adults. Third, age disparity in the coverage rate may also be explained by differing professional recommendations and public perceptions. Although perceived effectiveness of vaccination which was only a predictor for younger adults may have a positive effect on vaccine uptake in younger adults, perceived susceptibility to influenza and awareness of the free influenza vaccine policy were only associated with vaccine uptake in older adults. Moreover, older adults reported receiving recommendations from healthcare professionals more frequently than younger adults, and less likely to be concerned about side effects of the vaccine. These factors affecting vaccine uptake in both age groups may have led to increased uptake.

Recommendations from healthcare workers were the most important factor affecting influenza vaccination uptake in both older and younger adults; previous studies also showed this result [20-21]. Although healthcare workers are the foremost roles who can encourage people to be

vaccinated, the vaccination coverage among healthcare workers themselves in Beijing was low. A previous study found only a quarter of healthcare workers received the vaccine against pandemic influenza in the 2009/2010 season, 60% were concerned about side effects, and half had doubts about the vaccine's effectiveness [22]. Therefore, health promotion activities should be conducted not only for the general population but also for healthcare professionals. More measures should also be taken to motivate these workers to recommend influenza vaccination.

Consistent with two recent meta-analyses [13,23], the present study documented that public perceptions including concerns about susceptibility to influenza, doubts about the vaccine's effectiveness, and fears of side effects can influence the vaccine uptake. Age-related differences were found in perceived susceptibility to influenza and awareness of the free influenza vaccine policy being risk factors for older adults, perceived effectiveness of vaccination for younger adults, and perceived side effects of vaccination for both. In the present study, two-fifths did not report fear of catching influenza, 18.5% did not report the influenza vaccine could prevent infection, and 60% reported fear of side effects. The results indicated that accurate information about the severity of the disease, susceptibility to influenza, and vaccine effectiveness and side effects should be conveyed to the public when holding vaccination campaigns in Beijing.

Higher educational attainment is usually considered positively associated with vaccination uptake [24]. Conversely, we found that lower levels of education had a positive impact on vaccination uptake; a result consistent with our previous study [11]. In this study, multiple logistic regression analysis by age showed lower education was a risk factor for vaccination in both older and younger adults, and income was not. In other words, influenza vaccination was significantly influenced by educational attainment, independent of age and income. Several reasons may contribute to the higher coverage rate among lower-educated people. First, in recent years, media broadcasts and internet discussions targeting vaccine-related adverse outcomes have brought public suspicion in China about influenza vaccination [25]. Lower-educated people are less likely to be exposed to such information [11], and this may have a positive effect on vaccination. Our results, which supported this assumption, showed for both younger and older adults, lower-educated people were less likely to report fear of side effects, but more likely to report viewing influenza as a serious disease. Second, this study found lower-educated older adults more frequently reported receiving recommendations from healthcare workers than did those with higher levels of education. Third, for younger adults, lower-educated people were more likely to have a chronic illness, which was a risk factor for vaccination in this study.

This study found suffering from a fever or chronic illness was associated with greater intent to be vaccinated. That finding was consistent with Blank's study, and could be explained by heightened perceptions of personal risk [26]. We also found younger adults living in urban areas were more likely to receive the vaccine than those from suburban areas, and better access to vaccines may be the main reason for their intent to be vaccinated.

Strengths of this study are its large sample size of 7206 participants and its high response rate of 98.7%, implying the findings are highly representative and reliable. However, there are some limitations in this study. First, considering diversity of income levels and healthcare access across regions, our observations may not be effectively generalizable for other countries or regions. Additionally, because all the information was collected via a self-reported questionnaire, the investigators could not check the accuracy of responses, which may have led to reporting bias. Also, the respondents had to recall their experiences with vaccination; therefore, recall bias cannot be ruled out. Finally, the causal relationships could not be established because of the cross-sectional design.

CONCLUSIONS

This study demonstrated that the overall coverage rate of the influenza vaccine was relatively low (20.6%) among adults in Beijing during the 2014/2015 influenza season. For both older and younger adults, recommendations from healthcare workers were positively associated with influenza vaccination uptake; and perceived side effects of vaccination had a negative impact.

Age-related differences were found in perceived susceptibility to influenza and awareness of the free influenza vaccine policy being the factors affecting vaccine uptake for older adults, and perceived effectiveness of vaccination for younger adults. Apart from free vaccinations for older adults, age disparity in the rate between older and younger adults (48.7% vs. 16.0%) may be explained by differing professional recommendations and public perceptions. Vaccination campaigns that target increasing professional recommendations and public perceptions need to be implemented in the coming years.

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AUTHORS' CONTRIBUTIONS

SW, JS, PY and QW conceived of the study and participated in its design. SW, JS, HZ, HL, YC, WH, CL and YT collected the data. SW and JS analyzed the data. All authors helped to draft the manuscript and have read and approved the final manuscript.

COMPETIING INTERESTS

The authors declare that they have no competing interests.

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DATA SHARING STATEMENT

Other data can be requested by emailing the corresponding author.

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STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any pre-specified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	This study is not a cohort or case-control study.
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	5
		(*c*) Explain how missing data were addressed	5

		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	As a population based survey, the results of this study are clear. In my view, there is no need to describe any sensitivity analyses.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	The study is a population based survey and the study design is simple. Thus, there is no need to use a flow diagram.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5-6
		(b) Indicate number of participants with missing data for each variable of interest	6-8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	This study is not a cohort study.
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	This study is not a cohort study.
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	This study is not a *case-control study.*
		Cross-sectional study—Report numbers of outcome events or summary measures	6-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-10
		(*b*) Report category boundaries when continuous variables were categorized	6-10
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-10

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	10-11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.