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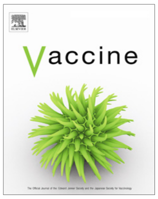

What influenza vaccination programmes are preferred by healthcare personnel? A discrete choice experiment

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ABSTRACT

Objectives: This study examined the relative importance of factors relating to vaccine characteristics, social normative influence and convenience in access to vaccine for determining decision making for seasonal influenza vaccination (SIV) among healthcare personnel (HCP), aiming to optimize existing influenza vaccination programmes for HCP.

Methods: A discrete choice experiment (DCE) was conducted in HCP working in public hospitals in Hong Kong. The DCE was designed to examine the relative importance of vaccine characteristics (vaccine efficacy and safety), social normative influence reflected by the proportion of HCP colleagues intending to take SIV, and convenience in access to vaccine indicated by vaccination programme duration, vaccination location, vaccination arrangement procedure and service hours in determining influenza vaccination choice among HCP. Mixed logit regression modelling was conducted to examine the preference weight (β) of factors included in the DCE for determining vaccination choice.

Results: Vaccination probability increased with increase in vaccine efficacy ($\beta = 0.02$ for per 1% increase), vaccination location changing from "designated staff clinic" to "mobile station" ($\beta = 0.37$), vaccination arrangement procedure changing from "by appointment" to "by walk-in" ($\beta = 0.99$), but decreased with the increase in probability of mild reactions to vaccination ($\beta = -0.05$ for per 1% increase).

Conclusion: Vaccine safety was judged to be more important than vaccine efficacy for determining vaccination choice. Arranging vaccination service by walk-in and implementing mobile vaccination station should be considered in future SIV programmes to compensate for the effect of perceived low vaccination efficacy and concerns about vaccine safety to promote SIV uptake among HCP.

1. Introduction

Healthcare personnel (HCP) have a significantly greater risk of seasonal influenza infection compared with general adults working in non-healthcare settings [1]. Work absenteeism among HCP increased significantly during influenza season compared with non-epidemic periods [2], leading to a substantial economic loss [3] and potential staff shortage for healthcare during influenza seasons [4,5]. Continued working with influenza-like illnesses among HCP was common, which can increase the spread of influenza to vulnerable patients [6,7]. There were also reports that influenza virus infections in HCP were associated with nosocomial outbreaks [8,9]. Seasonal influenza vaccination (SIV) can significantly reduce the risk of seasonal influenza virus infection among HCP, reduce work absenteeism and also confer the protection onward to patients and their families [1,10,11]. The World Health Organization recommends that HCP should be vaccinated against influenza each year and free SIV has been provided to HCP in many locations [12,13]. However, despite great efforts on promoting SIV among HCP, uptake rates remain unsatisfactory in the US [14], and widespread low in most European countries [15,16], Australia [17] and also in Hong Kong [18,19].

Psychological determinants of SIV uptake among HCP, including perceived effectiveness of SIV for preventing influenza virus infection, concerns about vaccine safety, and perceived personal risk of influenza virus infection have been consistently identified by observational studies [20–23]. However, interventional studies focusing on addressing these psychological factors through active educational campaign to promote positive attitudes towards SIV indicated mainly small effect sizes for promoting SIV uptake among HCP [24–26]. A systematic review suggested that

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interventions that additionally combined components addressing the contextual factors relating to vaccination could be more effective in promoting SIV uptake among HCP [12]. These context factors included normative influences on vaccination uptake (e.g., attitudes and SIV uptake among colleagues and employers) and convenience of access to influenza vaccine (e.g., time, location and procedure of access to vaccine). However, it is not clear which components are more important to determine resource allocation and optimize an influenza vaccination programme for promoting SIV uptake in HCP.

Discrete choice experiment (DCE) is a commonly used methodology for optimizing medical interventions [27]. In respect of a vaccination programme, DCE decomposes a vaccination programme into several important attributes such as vaccine efficacy and vaccine safety which can be further characterized by attribute levels (e.g., a vaccine efficacy of 60% or 80%). The attributes and attribute levels are then used to construct a series of choice sets each comprising 2–3 alternative hypothetical vaccination programmes and participants are asked to choose a preferred programme within each choice set. Through analyzing participants' trade-off between attributes and attribute levels in a series of choice sets, DCE enable examination of the relative importance of the selected attributes and attribute levels for determining vaccination preference. One recent study suggests that DCE is a valid method for predicting real-world influenza vaccination decision [28]. Several studies have used DCE to examine factors that determine preference for influenza vaccination [29–32]. However, none were conducted among HCP. In addition, all of these studies mainly chose attributes related to the characteristics of influenza vaccines [29–32] and only two additionally included attributes of social normative influence (e.g., doctors' recommendation and others' opinions) [30,32] in the DCE. The contextual factors related to convenience in access to influenza vaccine were generally overlooked.

This study used DCE to examine the relative importance of attributes related to vaccine characteristics, social normative influence and convenience in access to influenza vaccine for determining HCP's preference for SIV. The final aim was to identify the optimal SIV programme for promoting SIV uptake among HCP.

2. Methods

2.1. DCE questionnaire

Development of the DCE questionnaire involves choosing attributes, defining attribute levels and constructing choice tasks. The attributes included in a DCE was limited to those most important for HCP in their decision for vaccination against influenza to improve accuracy and reliability in the elicitation of preference. Before conducting this DCE, we conducted a questionnaire-based longitudinal survey to identify important determinants of SIV uptake among HCP in Hong Kong [18]. In that study, attitudes towards SIV was the strongest factor that influenced uptake of SIV among HCP, which were mainly assessed by measuring participants' perceived effectiveness and safety of SIV. Therefore, vaccine efficacy and probability of vaccine reactions were included as attributes in the DCE. Social normative influence (other people particularly colleagues' opinions and vaccination uptake) was also suggested to be important determinants of SIV uptake in HCP [18]. Therefore, a third attribute, the proportion of colleagues intending to take SIV was included in the DCE. This indicates how much acceptable SIV is in the community of the target population which is an important attribute for influenza vaccination decision [32]. Furthermore, contextual factors including time, vaccination location (e.g., on designated or mobile sites) and procedure (vaccination required by appointment or walk-in) that affect convenience in access to SIV were reported to be important reasons for refusing SIV among the participants in the survey (data not reported). Since the contextual factors are important for characterizing a vaccination programme, they were also included in our DCE to provide important information for how to optimize the vaccination programme for HCP.

After choosing attributes, the levels of each attribute were defined based on the principle that the attribute levels should be realistic for real-life situation and meaningful for policy making. The final attributes and attribute levels chosen for this DCE were: Vaccine Efficacy covering four levels (20%, 40%, 60% and 80%) with the lowest level represents a poorly-matched vaccine strain and the highest represent a well-matched vaccine strain, probability of mild Vaccine Adverse Events (mild flu-like symptoms) comprising four levels (5%, 10%, 15% and 20%), Program Duration comprising two levels (Level 1: the ordinal fall immunization season and the first month of influenza season in Hong Kong (October-January); Level 2: extending the programme duration to the end of influenza season (October-March)), Vaccination Location (Level 1: designated staff clinic; Level 2: mobile station), Vaccination Arrangement Procedure (Level 1: by appointment; Level 2: by walk-in), Service Hours for vaccination administration covering four levels differed by whether vaccination service was provided during lunch time (1 pm-2 pm) and late afternoon (5 pm–6 pm) (Level 1: 9 am-1 pm, 2 pm-5 pm; Level 2: 9 am-5 pm (also opens at lunch time); Level 3: 9 am-1 pm, 2 pm-6 pm; Level 4: 9am-6 pm (also opens at lunch time)), and Proportion of Colleagues intending to take SIV (four levels: 40%, 50%, 60% and 70%) (Table 1). These attributes and attribute levels can generate a total of $4 \times 4 \times 2 \times 2 \times 2 \times 4 \times 4 = 2048$ scenarios with each representing a hypothetical influenza vaccination programme. It is not realistic to present all these hypothetical programmes to participants. Several alternative approaches are available for choosing a subset of scenarios from the pool such as orthogonal design and D-efficient design [33]. While recent research suggests that, a D-efficient design is more flexible and can improve the precision of parameter

Table 1
Attributes and levels in the Discrete Choice Experiment.

Attributes	Levels
Vaccine Efficacy	20% 40% 60% 80%
Vaccine Adverse Events (Probability of mild vaccine adverse events (mild flu-like symptoms))	5% 10% 15% 20%
Programme Duration	4 months (October to January) 6 months (October to March)
Vaccination Location	Designated staff clinic Mobile station
Vaccination Arrangement Procedure	By appointment By walk-in
Vaccination Service Hours	9 am-1 pm; 2 pm-5 pm 9 am-5 pm (also opens at lunch time) 9 am-1 pm; 2 pm-6 pm 9 am-6 pm (also opens at lunch time)
Proportion of Colleagues intending to take SIV	40% 50% 60% 70%

estimates by minimizing the covariance between parameter values than an orthogonal design, using a D-efficient design requires some prior knowledge of the parameter values and using more complex simulation procedure with specific software (e.g., Ngene) [34]. In comparison, orthogonal design is easier to implement and is suitable when prior knowledge of the parameter values is not available and when researchers are mainly interested in the main effects of each attribute level [33]. Therefore, this study used a fractional factorial designed based on orthogonal arrays [35] to choose 16 hypothetical programmes from the pool. The chosen 16 hypothetical programmes were then used to construct eight choice tasks, each presented participants with two alternative hypothetical programmes and participants were asked to choose the programme they preferred: "Programme A", "Programme B", or "Neither A nor B" (an opt-out option). One additional choice task which purposively presented a logically superior Programme B than Programme A was additionally included for rationality test before the eight main choice tasks in the DCE questionnaire. The rationality test was aimed to identify participants who were "irrational" or potentially have difficulties to understand the main choice tasks. The questionnaire was tested for comprehensibility and difficulty before being used in the formal survey. One example choice task is shown in S1.

3. Participants and procedure

In Hong Kong, the fall influenza vaccination campaign starts in October each year and all HCP are recommended to receive SIV before the winter influenza season that typically peaks in January-March annually [36]. Hong Kong's healthcare system operates along a dual track that comprises a public sector that dominates the secondary and tertiary care, managing ~80% of all hospital admissions, and a private sector that complements the public sector to provide mostly ambulatory primary care services [37]. This study only recruited HCP who worked in hospitals of the public sector and eligible to receive free SIV [38]. Participants who participated in our previous questionnaire survey on determinants of SIV uptake in July 2017-April 2018 [18] and gave consent for re-contacting were invited to complete the DCE in July-September 2018. Subjects for the previous questionnaire survey were recruited using convenience sampling through sending email, telephone calls or poster advertisement at public hospitals of Hong Kong. HCP who worked in a public hospital, being able to fluently communicate with English, Cantonese or Mandarin, were eligible to participate in the study. Each participant was invited to complete a 15–20 min in-person or web-based DCE questionnaire whichever they found convenient. All participants gave informed consent before participating in the study. The study received ethical approval from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.

3.1. Statistical analysis

Participants' elicited preferences were analyzed using a mixed logit regression model to allow heterogeneity as well as correlation between the choices from each participant [39]. After testing the linear continuous effects of the chosen attributes, Vaccine Efficacy and risk of Vaccine Adverse Events were treated as continuous variables while other attributes including Programme Duration, Vaccination Location, Vaccination Arrangement Procedure, Vaccination Service Hours and Proportion of Colleagues intending to take SIV were treated as categorical variables. For the categorical attributes, a dummy variable was created for each attribute level excepting for the reference level. The preference weight (β) for each attribute and attribute level was calculated by the mixed logit regression model. The statistical significance of a coefficient is set to *p*-value less than 0.05, indicating that individuals differ between one attribute level and the other in making stated choices. To investigate the willingness of participants to trade off an attribute to achieve an improvement in one level of the other attribute (i.e. the compensatory effects between attributes), we calculated the ratios of the coefficients of more important attributes relative to less important attributes. Finally, vaccination choice probabilities (expected mean uptakes) were also calculated to convey DCE results into easily understood information to policy makers, which was calculated by taking the exponent of the total utility for vaccination given specific attribute levels divided by the exponent of utility of both vaccination and no vaccination [39]. We first calculated the expected mean uptake rate for the base case defined as the programme with the least preferred attribute levels of vaccine characteristics (20% vaccine efficacy and 20% risk of vaccine adverse effect), 40% of colleagues intending to take SIV and contextual factors of existing SIV service—a programme duration of six month with vaccine being provided at a designated staff clinic by appointment during ordinal office hours (9 am-1 pm; 2 pm-5 pm). Then we calculated the change in vaccination uptake rate with one level change in a particular attribute compared with the base case while holding levels of other attributes constant. This would inform the relative importance of manipulating different attributes in affecting vaccination choice.

All statistical analyses were conducted using the STATA15.1 (StataCorp LLC, 1985–2017).

4. Results

A total of 258 HCP completed the DCE. Demographics of participants who completed the DCE are shown in Table 2. Overall, of the

Table 2
Demographics of participants who completed the DCE.

	N (%)
Female	189 (73.3)
Age group (years)	
≤30	75 (29.1)
30–39	97 (37.6)
40–49	55 (21.3)
≥50	31 (12.0)
Occupation	
Nurse/nursing assistant	113 (43.8)
Clerical/administrative/research staff	79 (30.6)
Laboratory/other technical staff	31 (12.0)
Allied health workers	27 (10.5)
Doctor	8 (3.1)
Education	
Secondary or below	60 (23.3)
Post-secondary non-tertiary	41 (15.9)
Bachelor	88 (34.1)
Master or above	69 (26.8)
Monthly income (HK$)[a]	
≤20 K	63 (24.4)
20 K-40 K	105 (40.7)
>40 K	84 (32.5)
Work experience	
≤5 years	66 (25.6)
6–10 years	72 (27.9)
11–20 years	59 (22.9)
>20 years	61 (23.6)
Frequency of contact with patients	
None	30 (11.6)
Rarely	39 (15.1)
Sometimes	37 (14.3)
Often	152 (58.9)

[a] 1HK$=~0.13US$.

participants, most were female; the main occupational category was nurse or nursing assistant; and more than one half had an educational attainment of tertiary or above and had frequent contact with patient (Table 2). Each participant completed a total of nine choice tasks including one choice task for the rationality test and eight main choice tasks. In the rationality test, 82.2% of the participants chose Alternative B, the logically superior alternative within the choice task for rationality test. Participants who chose Alternative A in the rationality test were more likely to be older (χ^2_4 = 14.20, p = 0.007) and had a longer experience of working in the hospital (χ^2_4 = 14.92, p = 0.005). For the main DCE choice tasks, 10.1–58.9% of the participants chose either Alternative A or Alternative B for taking vaccination, and 13.2–35.7% of them chose neither A nor B (“opt-out”).

The relative importance weights (preference weight coefficients) of the selected attributes and attribute levels of an influenza vaccination programme for determining participants’ preference for influenza vaccination are shown in Table 3. It shows that except for Programme Duration, all attributes are significantly associated with participants’ preference for choosing influenza vaccination. Participants’ preference for choosing influenza vaccination increased with the increase in Vaccine Efficacy, Vaccination Location changing from “designated staff clinic” to “mobile station” and Vaccination Arrangement Procedure changing from “by appointment” to “by walk-in”, but decreased with increase in probability of Vaccine Adverse Events, extending Opening Hours from “5pm” to “6pm”, and knowing that 60% or more of their colleges intending to take SIV. Excluding participants who “failed” in the rationality test (i.e., choosing Alternative A) only slightly changed the coefficients but did not change the overall conclusion (S2).

Based on the estimated preference weights (Table 3), the compensatory effects between attributes were calculated for Vaccine Efficacy, Vaccination Location, Vaccination Arrangement Procedure and probability of Vaccine Adverse Events. It shows that 20% increase in probability of Vaccine Adverse Events (reduction in vaccination preference weight = 20 * 0.05 = 1.00) can be compensated by 50% increase in Vaccine Efficacy (change in vaccination preference weight = 50 * 0.02 = 1.00) and changing the Vaccination Arrangement Procedure from “by appointment” to “by walk-in”. Changing the vaccination location from “designated staff clinic” to “mobile station” can compensate the negative effect of 7% increase in probability of Vaccine Adverse Events.

Table 3
Preference weights for vaccination decision of different attributes and attribute levels.

Attribute and attribute level	Coefficient (95%CI)	Standard Error
Vaccine Efficacy (per 1% increase)	0.02 (0.02, 0.03) [c]	0.003
Vaccine Adverse Events (per 1% increase)	−0.05 (−0.07, −0.03)[c]	0.009
Programme Duration		
Level 1: Oct-Mar (6 months)	Reference	
Level 2: Oct-Jan (4 months)	−0.005 (-0.18, 0.17)	0.09
Vaccination Location		
Level 1: Designated staff clinic	Reference	
Level 2: Mobile station	0.37 (0.11, 0.62)[b]	0.13
Vaccination Arrangement Procedure		
Level 1: By appointment	Reference	
Level 2: By walk in	0.99 (0.66, 1.32)[c]	0.17
Vaccination Service Hours		
Level 1: 9am-1 pm, 2 pm-5 pm	Reference	
Level 2: 9am-5 pm (also opens at lunch time)	0.10 (−0.15, 0.34)	0.12
Level 3: 9am-1 pm, 2 pm-6 pm	−0.54 (−0.86, −0.23)[b]	0.16
Level 4: 9am-6 pm (also opens at lunch time)	−0.37 (−0.63, −0.10)[b]	0.14
Proportion of Colleagues intending to take SIV		
Level 1: 40%	Reference	
Level 2: 50%	0.03(−0.40, 0.46)	0.22
Level 3: 60%	−1.73 (−2.10, −1.36)[c]	0.19
Level 4: 70%	−0.49 (−0.74, −0.24)[b]	0.13
Log-likelihood	−1848.59	
AIC	3737.17	
BIC	3871.79	

[a] $p < 0.05$.
[b] $p < 0.01$.
[c] $p < 0.001$.

Changes in expected mean vaccination uptake rate with the changes in Vaccine Efficacy, probability of Vaccine Adverse Events, Vaccination Location and Vaccination Arrangement Procedure were calculated because these attributes were significantly associated with how to optimize a SIV programme for HCP in the model. It shows that in the base case, the expected mean vaccination uptake rate is around 31.0%. Expected mean uptake rates can increase to 59.6% if Vaccination Arrangement Procedure changes from “by appointment” to “by walk-in”, to 59.4% if Vaccine Efficacy increases from 20% to 80%, to 53.7% if probability of Vaccine Adverse Events decreases from 20% to zero (by changing the effect of Vaccine Adverse Events from −0.05 × 20 = −1.00 to zero on total utility for vaccination), and to 44.3% if mobile vaccination station is implemented (Fig. 1).

5. Discussion

In this DCE, we found that vaccination probability increased with the increase in vaccine efficacy and decrease in probability of vaccine adverse events. This finding is consistent with existing studies based on questionnaire surveys [20–23]. Adding to existing literature, the DCE further measured the relative importance of vaccine efficacy to vaccine safety in determining HCP’s preference for influenza vaccination. Based on their preference weights, it is suggested that the decline in vaccination probability due to a 20% increase in probability of vaccine adverse events can be compensated by at least 50% increase in vaccine efficacy. This means that vaccine safety is at least two times more important than vaccine efficacy in determining vaccination probability, suggesting a loss aversion phenomenon in personal vaccination decision [40]. However, this finding was different to that of a DCE survey on Dutch public preference for influenza vaccination during hypothetical influenza pandemic which reported vaccine effectiveness was the most important attribute determining vaccination preference followed by vaccine safety [32]. The inconsistent conclusions between the two studies may be due to the different characteristics between seasonal influenza and pandemic influenza of which the former is usually perceived to be mild and severity is not a significant predictor of vaccination uptake [18] while acceptability for vaccine risk can become greater during influenza pandemic of greater severity [32]. For the current coronavirus disease pandemic, acceptability of the vaccine risk, if any, could also depend on the perceived severity of the disease by the time when the vaccine is available in the target population [30].

Among the contextual factors, procedure of vaccination arrangement had the strongest positive effect on vaccination preference. Merely changing the procedure of vaccination arrangement from “by-appointment” to “by walk-in” can compensate the negative effect of ~ 20% increase in probability of vaccine adverse events on vaccination probability. The procedure that requires individuals to book an appointment for their vaccination (the ‘opt-in’ procedure) beforehand has been suggested to be a barrier for taking SIV [41]. The “walk-in” procedure represents an appointment by default without constraining time to receive the vaccination services. This can greatly increase the convenience in access to vaccination services and thereby increase vaccination probability [41,42]. Changing the vaccination location from a “designated staff

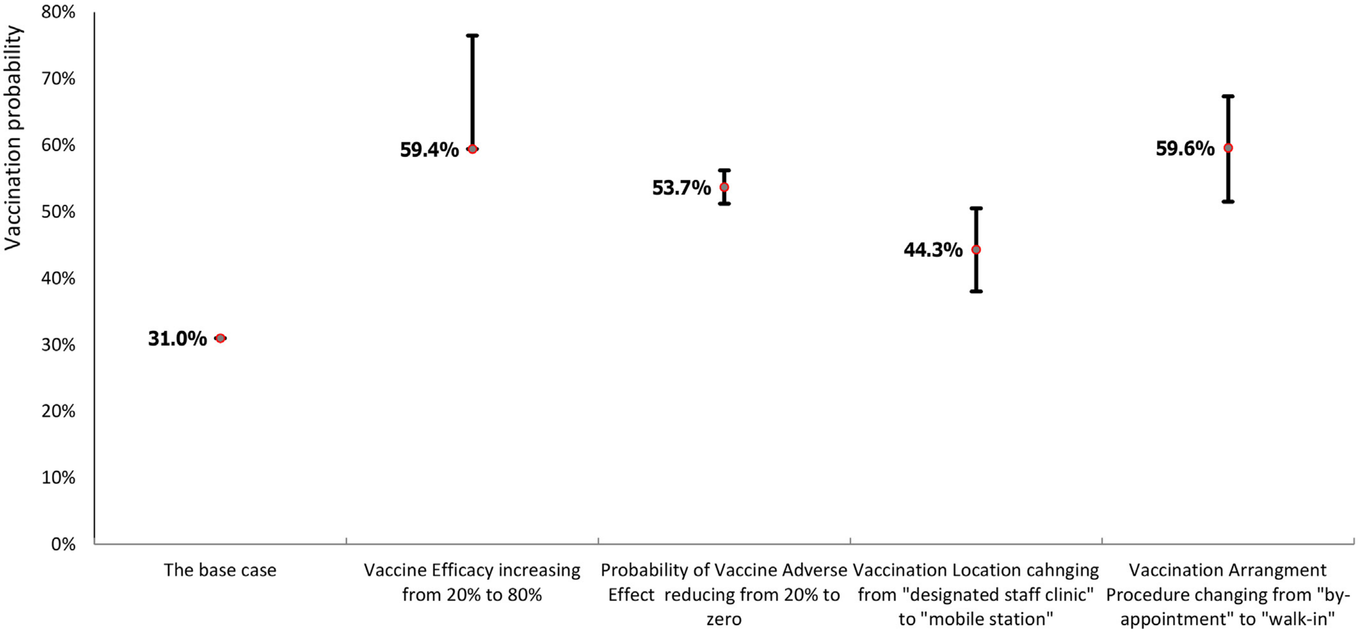

Fig. 1. Change in vaccination probability with the change in attributes. The error bar indicates the 95% confidence interval of the vaccination probability with the change in specific attribute.

clinic" to a "mobile station" was another factor that can significantly increase vaccination probability. Previous studies also indicated that providing on-site vaccination was associated with greater SIV uptake among HCP [14,43]. However, although others argued that extending vaccination delivering period from the conventional fall immunization season to cover the whole influenza season and extending the office hours of vaccination administration could increase vaccine access and thereby promote SIV uptake [42], our study found no significant effect of extending the vaccination programme period and a negative effect of extending office hours of vaccination administration on vaccination probability. This indicates that individuals who miss vaccination at the traditional immunization period are unlikely to catch up their vaccination uptake during main influenza season which is deemed to be late for protecting against influenza infection. For timing of vaccination, extending the vaccination service hours to late afternoon (5:00 pm to 6:00 pm) significantly reduced participants' preference for taking influenza vaccination. This reflects that participants may have concerns over receiving influenza vaccination in late afternoon. Potential concerns may include perception of insufficient day time to observe the vaccine side effects and being unwilling to put extra burden to their colleague who provided vaccination services but actual concerns await further exploration.

Notifying a greater percentage of colleagues intending to take SIV did not increase vaccination probability but instead, knowing that 60% or above of their colleagues intending to take SIV reduce preference for taking SIV. This seems contradictive with existing social norm theories which propose that perceiving greater approval of an intervention in peers can improve acceptance of the intervention [44,45]. However, it is consistent with "free-rider" behaviours in vaccination decision [30,46,47]. Individuals may avoid vaccination risk when perceiving that the vaccination coverage is sufficiently high to generate herd immunity [30,46,47], a phenomenon that unvaccinated individuals can get indirection protection from others' vaccination uptake. If this explanation is true, participants may have overlooked main risk source of influenza transmission from patients instead of their colleagues. It may also reflect the influence of some psychological roots such as reactance or individualism of anti-vaccination attitudes on vaccination decision [48]. Some individuals tend to reject consensus views on vaccination and dislike follow others to make their vaccination decision [48]. If true, this may be a challenge for implementing the mandatory influenza vaccination policy in HCP [49]. Another possibility is that peers' behaviours may have an implicit [18] or direct effect on actual vaccination behaviours [50] in real life rather than on the stated vaccination preference which thereby cannot be assessed in a DCE. However, this finding may not be generalized to people's vaccination decision in a severe pandemic when disease severity can become the dominant determinant on vaccination choice but "free-rider" behaviours remain possible when vaccine safety is perceived to be more uncertain [30].

An expected mean vaccination uptake rate of 31% for the base case calculated using the estimated preference weights of the attributes in the DCE was approximately the same as the observed vaccination uptake of 30.8% in HCP from our separate questionnaire survey [18], representing an indirect validation of the DCE findings. Increasing vaccination efficacy from 20% to 80% or reducing probability of vaccine adverse events from 20% to zero could increase vaccination uptake rate to over 50%. However, promoting vaccination efficacy and reducing vaccine side effects can meet technical and contextual barriers such as how accurate the scientists can estimate the main circulating influenza strain in an influenza season and vaccination production technology. Instead, our study suggests that simply changing the vaccination delivery procedure from providing by appointment to by walk-in can increase vaccination uptake rate to over 50%. Implementing mobile vaccination stations may further promote vaccination uptake.

This study has several limitations. First, our study only recruited HCP in public hospitals in Hong Kong. Therefore, the findings may not be applicable to HCP working in other healthcare settings particularly those working in the private sector for whom free SIV may not be completely subsidized. Second, participants were those who gave consent to be re-contacted in our previous SIV survey and thereby may be those who were more interested in SIV. However, post-hoc analysis indicates no significant difference in past-year SIV uptake rates between those who participated and those who did not participated in the current DCE. Third, despite multiple ways had been used to recruit HCP of different occupational categories [18], only a small proportion of our participants were doctors. However, our previous survey found that doctors generally had more favourable attitudes towards SIV and greater intention to take SIV than nurses, nursing assistants and other HCP[18]. This means that our study findings mainly reveal the relative importance of main determinants on SIV choice among HCP who should be the main target population of future influenza vaccination programme. Fourth, the proportion of HCP colleagues intending to take SIV along may not be a sufficient attribute to reflect the social normative influence on vaccination decision. Future DCE should consider including opinions from Department Head or employers for SIV. Furthermore, although both textual and graphical formats were used to illustrate most attributes and attribute levels, some participants may still have difficult to understand the choice tasks. Despite this, excluding the minority of participants who failed in the 'rationality test' did not change the conclusions of our study.

6. Conclusion

Vaccine safety was more important than vaccine efficacy for determining vaccination probability in the context of seasonal influenza. Changing the vaccination arrangement procedure from by appointment to by walk-in can compensate the negative effect of a 20% increase in probability of mild reactions to vaccination or a 50% decline in vaccine efficacy, resulting in a vaccination uptake rate of over 50% in HCP. Implementing mobile vaccination stations could further increase vaccination uptake.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2020.05.012.

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