






RESEARCH PAPER



## Determinants of change in intention to receive influenza vaccination among health-care workers in Singapore

Dwee Wee Lim <sup>a,b</sup>, Hanley J. Ho <sup>a</sup>, Lay Tin Lee <sup>b</sup>, Angela Chow <sup>a</sup>, and Win Mar Kyaw <sup>a</sup>

<sup>a</sup>Department of Clinical Epidemiology, Office of Clinical Epidemiology, Analytics, and Knowledge, Tan Tock Seng Hospital, Singapore; <sup>b</sup>Occupational Health Services, Tan Tock Seng Hospital, Singapore

### ABSTRACT

Understanding the change in intention for influenza vaccine among health-care workers (HCWs) is important to increase influenza vaccination uptake. We aimed to investigate the psychosocial beliefs associated with a change in the intention for influenza vaccine. An anonymous cross-sectional survey was distributed to tertiary hospital HCWs in 2016. Of 3007 HCWs, 70% were compliant (vaccinated, with an intention to revaccinate), 8% were resistant (unvaccinated, without intention to vaccinate), 10% had positive change (unvaccinated, but with intention) and 12% had negative change (vaccinated, but without intention). Across HCW groups, medical staff had both the highest proportion receiving all influenza vaccinations in the last 5 years (101, 28.4%), as well as the highest proportion who had never received vaccination (41, 11.5%). With increasing age, HCWs were less likely to have a negative ( $p = .02$ ) or positive change ( $p = .06$ ) in intention, compared to the vaccine-resistant group. HCWs were more likely to be compliant or have a positive change in intention to receive influenza vaccine, if they perceived the vaccine as effective, safe, or had a higher frequency of influenza vaccination in the last 5 years (all with  $p < .05$ ). HCWs who were medical staff, who believed that side effects of the vaccine were common, or had worked for 6 to 10 years (vs 5 years or less) were less likely to be compliant (all with  $p < .05$ ). In conclusion, older HCWs were more likely to maintain the status quo in their behavior toward influenza vaccination. Influenza vaccination strategies should place emphasis on vaccine effectiveness and safety.

### ARTICLE HISTORY

Received 21 July 2019  
Revised 4 October 2019  
Accepted 24 October 2019

### KEYWORDS



Healthcare personnel; hospital; influenza vaccination; health communication; health behavior

### Introduction

Healthcare-associated influenza increases the risk of mortality and severe morbidity among hospitalized patients.<sup>1</sup> Influenza vaccination among health-care workers (HCWs) reduces transmission of the disease in health-care settings, absenteeism among staff, and potentially overall health-care costs.<sup>2–6</sup> Various strategies have been adopted to encourage HCWs to consistently receive influenza vaccination. These include mandatory influenza vaccination implemented in certain hospitals in the United States.<sup>1,7</sup> Other countries without such policies, such as Singapore and Australia, promote influenza vaccination uptake through annual vaccination campaigns.<sup>8,9</sup>

Predictors of influenza vaccine uptake among HCWs are well-documented and include personal psychosocial beliefs, accessibility and availability of vaccines, and self-efficacy, which can be categorized under various constructs of the Health Belief Model.<sup>4,10–13</sup> The important attitudes and beliefs were motivation to protect themselves and their family, perceived norms to receive influenza vaccine, belief in vaccine effectiveness and safety, heightened perceived susceptibility to influenza, and perceived influenza as a severe illness.<sup>4,8,14–17</sup> Studies have also evaluated vaccination behavior from the dimension of vaccine continuity and adherence to influenza vaccination.<sup>10,18–20</sup> The predictors, such as belief that vaccination is safe and effective, and belief that an influenza infection

might lead to serious illness, were similar to that of vaccine uptake.<sup>10</sup> Human behavior is complex. Decisions on influenza vaccination include an evaluation of cost and benefits,<sup>21,22</sup> and HCWs' intention for influenza vaccination could also change over time. The decision depend on the context, setting, and their personal experience.<sup>13</sup> In Spain, 30% of participants who had received influenza vaccine previously were not revaccinated against influenza, while 5% of HCWs who were never vaccinated, received the influenza vaccine.<sup>18</sup> A study also showed among those who had past influenza vaccination, reluctance to attempt new behavior, also known as “status quo” bias, affected their decision for future vaccination.<sup>22</sup> Nevertheless, few studies have explored the predictors for change in vaccination intention. A study in the United Kingdom showed participants who were in the “never vaccinated” group had the lowest knowledge and risk perception scores compared to the “newly vaccinated”, “continuously vaccinated” and “used to be vaccinated” groups. The authors did not explore differences in psychosocial factors between the “newly vaccinated” and “never vaccinated” groups.<sup>23</sup> These predictors help in understanding the factors initiating change among those who have not received influenza vaccination. Sociocognitive predictors for influenza vaccine intention were reported to be different between health-care workers in Belgian, Dutch and German hospitals.<sup>14</sup> As such,

**CONTACT** Hanley J Ho  [hanleyho@gmail.com](mailto:hanleyho@gmail.com)  Department of Clinical Epidemiology, Office of Clinical Epidemiology, Analytics, and Knowledge, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, 308433, Singapore

© 2019 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

determinants for change in intention to receive influenza vaccine may differ in the Asian context from those in Western countries. We have previously reported factors associated with vaccine uptake but the correlates for change in vaccination practice were not examined.<sup>16</sup> Therefore, in this study, we aimed to identify psychosocial factors associated with positive change and compliance in influenza vaccination intention among HCWs in a large Asian tertiary care hospital.

## Materials and methods

### Study design and setting

We conducted a single-center, cross-sectional study at Tan Tock Seng Hospital (TTSH), Singapore, from April to May 2016 during the annual seasonal influenza vaccination campaign. TTSH is a 1,600 bed acute care tertiary hospital with more than 8,000 workers. The hospital has all medical and surgical specialties and subspecialties except for Pediatric and Obstetrics and Gynecology. In this hospital, annual influenza vaccination is offered to all employees free of charge, and the vaccination promotion campaign is performed through e-mails, posters, word of mouth, and mobile vaccination teams. During the campaign, HCWs were encouraged to receive influenza vaccination during work events, but no personal reminders for influenza vaccination were given.

### Study questionnaire

The study used a standardized anonymous, self-administered questionnaire developed based on constructs from the Health Belief Model, including perceived benefits and barriers to influenza vaccination, and perceived susceptibility and severity of influenza illness.<sup>24</sup> It consisted of five sections with a total of 18 questions. This has been detailed in a previous publication.<sup>16</sup> Section one and five collected information on demographics (age and gender), occupation, presence of chronic diseases and duration of employment in the health-care sector. Section two enquired on the frequency of influenza vaccination for the last 5 years, status of influenza vaccination in 2015 and intention for influenza vaccination in 2016. Section three asked for reasons for accepting or refusing the influenza vaccine, using a pre-defined list of reasons for participants to choose from and a free-text field for additional comments. In section four, we assessed participants' beliefs and attitudes on influenza and influenza vaccination, based on how strongly they agreed or disagreed with provided statements on a 4-point Likert scale. There were a total of nine statements covering the perceived risks and benefits/effectiveness of the influenza vaccine, and perceived susceptibility and severity of influenza. We also asked for recommendations to increase influenza vaccine uptake from participants with a pre-defined list and a free-text field. The questionnaire was piloted on 30 HCWs with demographics and occupational distribution similar to the study population.

Both online and hard copy versions of the study questionnaire were used. The online version was hosted on the

Qualtrics platform (Qualtrics, Provo, UT) and the link to the questionnaire was sent to all hospital staff with e-mail access, after obtaining permission from the senior management of the hospital. The e-mail also highlighted that participation was voluntary and stated the objective and background of the study. Another reminder e-mail was sent out 3 weeks later. The hard copy version was distributed by hand to all staff working at the hospital, and completed questionnaires were collected from a designated staff in each working area after 3 days. Staff members were reminded not to complete the questionnaire more than once in either modality.

By completing and returning the questionnaire, participants were taken to have given implied consent to be enrolled in the study. Ethics approval for the study was obtained from the National Healthcare Group Domain Specific Review Board (DSRB reference number 2016/00050).

### Statistical analysis

A descriptive analysis for the cohort was performed. The responses for beliefs on influenza and influenza vaccination were converted into dichotomous variables, where the responses "strongly disagree" and "disagree", as well as "strongly agree" and "agree", were each combined into a single group for analysis. Differences in demographics were compared using the Chi-square test for categorical variables and the analysis of variance test for continuous variables. All statistical analysis was performed using Stata version 13 (Stata Corp., College Station, TX).

Participants were also further classified into four groups based on their vaccination status in the most recent 2015 Southern Hemisphere season and their intention for future vaccination. The four groups were defined as follows: "resistant" (did not receive influenza vaccine in the most recent season and did not intend to receive in future), "compliant" (received vaccine recently and intended to receive in future), "negative change" (received the vaccine recently but did not intend to receive in future), and "positive change" (did not receive the most recent vaccine, but intended to receive in future). The primary outcomes of interest were differences in demographics and beliefs across these four groups.

We used multinomial logistic regression to assess for factors independently associated with differing vaccination status and intentions to receive influenza vaccination, using the resistant group as the reference group. Statistical significance was defined as a *p*-value of <0.05.

## Results

The questionnaire was completed by 3,955 of 8,296 HCWs, giving a response rate of 48%. Of these, 948 respondents did not provide data on their demographics, their beliefs in influenza vaccination or the plan to be immunized in the future. The remaining 3,007 participants were included in this study. Of these, 2504 (83%) completed the online questionnaire and 503 (17%) completed the hard copy questionnaire. Compared to participants completing the hard copy questionnaire, those

**Table 1.** Characteristics of study participants, n (%) unless stated otherwise.

Characteristics	Resistant (n = 248)	Negative Change (n = 359)	Positive Change (n = 313)	Consistent (n = 2087)	Total (n = 3007)	P-value
Age, mean (SD) in years	32.7 (8.7)	32.0 (8.4)	30 (7.2)	33.8 (10)	33.1 (9.5)	<0.001
Gender						
Female	205 (82.7)	304 (84.7)	262 (83.7)	1741 (83.4)	2512 (83.5)	0.918
Male	43 (17.3)	55 (15.3)	51 (16.3)	346 (16.6)	495 (16.5)	
Years of service						
Less than 5 years	117 (47.2)	162 (45.1)	186 (59.4)	1001 (48)	1466 (48.8)	<0.001
6 to 10 years	70 (28.2)	118 (32.9)	81 (25.9)	537 (25.7)	806 (26.8)	
11 to 20 years	42 (16.9)	54 (15)	35 (11.2)	355 (17)	486 (16.2)	
More than 20 years	19 (7.7)	25 (7)	11 (3.5)	194 (9.3)	249 (8.3)	
Number of patients contact (per week)						
0 patients	28 (11.3)	37 (10.3)	29 (9.3)	165 (7.9)	259 (8.6)	0.067
1–20 patients	44 (17.7)	72 (20.1)	65 (20.8)	475 (22.8)	656 (21.8)	
21–50 patients	55 (22.2)	104 (29)	88 (28.1)	609 (29.2)	856 (28.5)	
More than 50 patients	121 (48.8)	146 (40.7)	131 (41.9)	838 (40.2)	1236 (41.1)	
Frequency of vaccination for the last five years						
0	127 (51.2)	5 (1.4)	88 (28.1)	18 (0.9)	238 (7.9)	<0.001
1	51 (20.6)	112 (31.2)	80 (25.6)	364 (17.4)	607 (20.2)	
2	40 (16.1)	111 (30.9)	64 (20.5)	388 (18.6)	603 (20.1)	
3	22 (8.9)	52 (14.5)	43 (13.7)	416 (19.9)	533 (17.7)	
4	4 (1.6)	33 (9.2)	29 (9.3)	305 (14.6)	371 (12.3)	
5	4 (1.6)	46 (12.8)	9 (2.9)	596 (28.6)	655 (21.8)	
Occupational groups						
Administration	18 (7.3)	34 (9.5)	24 (7.7)	162 (7.8)	238 (7.9)	0.002
Allied Health	60 (24.2)	78 (21.7)	71 (22.7)	352 (16.9)	561 (18.7)	
Ancillary	18 (7.3)	16 (4.5)	28 (9)	176 (8.4)	238 (7.9)	
Medical	38 (15.3)	35 (9.8)	42 (13.4)	241 (11.6)	356 (11.8)	
Nursing	114 (46)	196 (54.6)	148 (47.3)	1156 (55.4)	1614 (53.7)	

**Table 2.** Multinomial logistic regression of factors associated with the intention for influenza vaccination.

Variables	Patient group (vs Resistant group, n = 248)					
	Negative change (n = 359)		Positive change (n = 313)		Compliant (n = 2087)	
	AOR	(95% CI)	AOR	(95% CI)	AOR	(95% CI)
Knowledge, attitudes and beliefs						
Side effects after vaccination are common	0.78	(0.50–1.22)	0.81	(0.51–1.27)	<b>0.60</b>	<b>(0.40–0.90)</b>
Side effects after vaccination are not severe	0.91	(0.57–1.47)	1.30	(0.76–2.25)	1.29	(0.82–2.03)
Influenza is a potentially serious disease	1.14	(0.74–1.76)	0.90	(0.57–1.43)	1.42	(0.94–2.13)
Influenza vaccine is safe	1.19	(0.72–1.97)	<b>2.52</b>	<b>(1.26–5.05)</b>	<b>2.71</b>	<b>(1.63–4.52)</b>
Need to get vaccine yearly	0.74	(0.50–1.12)	<b>1.96</b>	<b>(1.21–3.16)</b>	<b>1.66</b>	<b>(1.13–2.46)</b>
Vaccine can cause flu	0.99	(0.67–1.45)	0.99	(0.67–1.47)	0.89	(0.63–1.26)
Vaccine is effective in preventing influenza	1.24	(0.79–1.94)	<b>2.28</b>	<b>(1.34–3.89)</b>	<b>2.27</b>	<b>(1.48–3.48)</b>
Vaccine is not effective in preventing flu	1.25	(0.81–1.94)	<b>0.27</b>	<b>(0.16–0.46)</b>	<b>0.35</b>	<b>(0.23–0.53)</b>
Vaccine is more dangerous than virus	0.72	(0.42–1.23)	0.90	(0.48–1.68)	0.86	(0.52–1.43)
Age (years)	<b>0.96</b>	<b>(0.93–0.99)</b>	0.97	(0.93–1.00)	0.99	(0.96–1.02)
Male gender (vs female)	1.14	(0.68–1.89)	1.12	(0.67–1.89)	1.29	(0.81–2.04)
Presence of chronic diseases	1.60	(0.61–4.21)	1.59	(0.56–4.50)	1.77	(0.71–4.41)
Years of service (vs 5 years or less)						
6 to 10 years	0.84	(0.53–1.34)	0.87	(0.54–1.41)	<b>0.43</b>	<b>(0.28–0.66)</b>
11 to 20 years	1.03	(0.52–2.06)	1.05	(0.51–2.17)	0.58	(0.31–1.09)
More than 20 years	1.72	(0.57–5.20)	1.11	(0.33–3.71)	0.61	(0.22–1.67)
Frequency of vaccination for the last 5 years	<b>2.83</b>	<b>(2.38–3.38)</b>	<b>1.87</b>	<b>(1.56–2.25)</b>	<b>4.13</b>	<b>(3.49–4.89)</b>
Number of patient contacts per week (vs 0 patients)						
1 to 20	1.30	(0.62–2.73)	1.46	(0.67–3.18)	<b>2.05</b>	<b>(1.03–4.06)</b>
21 to 50	1.61	(0.78–3.33)	1.91	(0.89–4.10)	<b>2.35</b>	<b>(1.19–4.62)</b>
More than 50	1.07	(0.55–2.08)	1.21	(0.60–2.43)	1.53	(0.83–2.85)
Healthcare groups (vs Nursing)						
Administration	1.18	(0.56–2.49)	1.14	(0.52–2.51)	0.91	(0.46–1.82)
Allied Health	0.79	(0.49–1.28)	1.27	(0.77–2.09)	0.72	(0.46–1.13)
Ancillary	0.55	(0.25–1.21)	1.08	(0.53–2.21)	0.93	(0.49–1.75)
Medical	<b>0.40</b>	<b>(0.21–0.75)</b>	0.65	(0.36–1.20)	<b>0.28</b>	<b>(0.16–0.49)</b>

Bold numbers indicate  $p$ -value < 0.05

who completed the online version were older (37 vs 32 years,  $p < .001$ ), and more likely to be male (25% vs 15%,  $p < .001$ ), have worked for over 20 years (15% vs 7%,  $p < .001$ ), have no patient contact (28% vs 5%,  $p < .001$ ) and have taken influenza vaccine annually for the last 5 years (28% vs 21%,  $p < .001$ ).

Of the 3,007 participants, 2446 (81%) reported receiving influenza vaccination during the most recent hospital vaccination programme, and 2,400 (80%) stated intention to receive influenza vaccination in the following season. Based on our group definitions, 2,087 (70%) participants formed the compliant group, 359 (12%) formed the negative change group, 313 (10%) formed the positive change group, and the remaining 248 (8%) formed the resistant group.

Table 1 summarizes the socio-demographic characteristics of participants. The mean age was 33 years (SD 9.5) and majority (84%) was female. More than half of the participants (51%) had worked for more than 5 years in the health-care profession. Nearly 80% of participants reported more than 20 patient contacts per week. This distribution of main occupational groups was reflective of our hospital's population, as verified with the hospital's human resource department. Significant differences between the different vaccine intention groups were observed for age, years of service, frequency of vaccination for the last 5 years and the occupational groups.

Majority of the participants perceived that influenza was a serious disease (84%), influenza vaccine was effective (82%) and safe (91%) but the side effects of influenza vaccine were common (72%). About one-third of participants (36%) thought that influenza vaccine could cause

influenza, and 9% suggested that the vaccine was more dangerous than the influenza virus itself.

### Primary outcomes

On univariate analysis, significant differences were observed between the compliant and resistant groups in all the vaccine beliefs and knowledge-related questions ( $p < .05$ ). On multivariable analysis (Table 2), the compliant group and positive change groups were similar in their psychosocial beliefs on influenza vaccine. Compared to the resistant group, both were more likely to perceive that vaccination was safe ( $p = .009$  and  $p < .001$ ), effective ( $p = .002$  and  $p < .001$ ), and should be taken yearly ( $p = .006$  and  $p = .011$ ). They had also more frequently received vaccination against influenza for the last 5 years (both  $p < .001$ ).

In addition, the compliant group was more likely to believe that side effects of influenza vaccination were uncommon ( $p = .013$ ), and have contact with 1–20 or 21–50 patients per week (vs no patient contact,  $p = .04$  and  $p = .013$ , respectively). The compliant group was less likely to be from the medical health-care group ( $p < .001$ ) or have 6 to 10 years of work experience (vs 5 years or less,  $p < .001$ ).

Compared to the resistant group, both the positive change and negative change groups were less likely to be of older age ( $p = .02$  and  $p = .056$ , respectively). The negative change group was also less likely to be from the medical health-care group (vs nursing,  $p < .001$ ).



## Discussion

This study showed a high influenza vaccination rate among HCWs and a high percentage with the intention to adhere to future hospital recommendations for annual vaccination (both around 80%). Several modifiable and non-modifiable factors for positive change and the intention to comply with the influenza vaccination were identified in this study.

The results also suggested that the “status quo” effect more strongly affected older HCWs. With increasing age, those who had been compliant or resistant remained as such. Younger HCWs might not have developed firm beliefs on influenza vaccine yet, and hence were more receptive to new information and health messages. However, older HCWs’ beliefs would have been shaped by their experience and past practices, and they might not have been as likely to change their health behavior. Given vaccine uptake is positively associated with receiving past influenza vaccine, nurturing the habit to receive the vaccine annually is important to increase influenza vaccine coverage.<sup>25</sup> Our results suggest that this habit should be inculcated at a younger age, ideally starting from the time when HCWs first join the health-care profession. For the older workers in the resistant group, a multi-pronged approach addressing their concerns might be needed to influence their beliefs and behavior.

Participants who had worked for 6 to 10 years were less likely to be compliant, compared to those who worked less than 5 years. This is contrary to a systematic review where one of the barriers to vaccination was fewer years of working experience.<sup>26</sup> It is possible that the influenza vaccination campaign in the hospital had a differential effect on the HCWs’ perception and intention for influenza vaccine, depending on their preexisting beliefs.<sup>27</sup> Furthermore, message fatigue could result in negative attitudes toward the recommended messages.<sup>28,29</sup> Recall of public health messages is inversely associated with number of messages received per week.<sup>30</sup> Those who have worked longer were also more susceptible to message fatigue as they were more likely to be in the senior position, have added responsibilities and high workload. Lastly, the beneficial effects of influenza vaccine might not be salient to HCWs who had been working for many years, as other pathogens may cause similar illness and prevention of influenza transmission is not easily observed in one single ward/work location.<sup>31</sup>

Our results add to the current knowledge that, in the local context, perceived vaccine effectiveness and safety are not only associated with vaccine uptake but are also important predictors for influenza vaccine intention change, independent of the frequency of past influenza vaccination. The observation that compliant and positive change groups were more likely to believe that influenza vaccine was effective and safe is consistent with international and local studies which associated influenza vaccine uptake and adherence with constructs from the Health Belief Model and Theory of Planned Behavior, which include effectiveness and safety beliefs.<sup>8,15,18,32-35</sup> HCWs’ perception on vaccine effectiveness and safety are subjected to biases from past experiences or anecdotes.<sup>7,34</sup> HCWs, especially those in the resistant group,

might attribute illnesses caused by other respiratory viruses and unpleasant symptoms to the influenza vaccine, even long after the vaccination date because the event was easy to recall.<sup>34</sup> As a result, the vaccine may be deemed ineffective. The act of injecting foreign material into the body increases the misconception.<sup>34</sup>

Mandatory influenza vaccination, where influenza vaccination is one of the condition for employment or severe restriction for unvaccinated HCWs, is the most effective measure to increase vaccination coverage among health-care workers.<sup>4,36</sup> Other effective strategies include declination form, mandatory policy without consequences, increased access and heightened awareness.<sup>36</sup> Innovative measures to deliver influenza vaccine messages could also prevent message fatigue and ignorance among existing HCWs.<sup>28</sup> The impact of each influenza campaigns strategies (e.g. mode, accessibility, and frequency) on message fatigue will need to be explored to ensure the effectiveness of the influenza campaign and efficient use of resources.

Interventions will also need to improve the perceptions of HCWs on influenza vaccine effectiveness and safety, the two most important psychosocial determinants in this hospital context. However, providing figures on vaccine effectiveness may not be sufficient as the effectiveness of the influenza vaccine fluctuates annually.<sup>11,32,34</sup> Some HCWs also cited a lack of evidence showing that influenza rates among patients could be reduced by vaccinating HCWs.<sup>4</sup> Based on behavioral theories, information about the influenza vaccine including the safety, effectiveness, and benefits that are disseminated by peers and reputable physicians may increase confidence in the vaccine.<sup>32,37</sup> Hospitals could leverage on individual, social, environmental and policy determinants to increase the vaccine adherence, especially among the older workers who are resistant.

Our study had some limitations. Firstly, the modest participation rate might pose potential selection bias. We incorporated two methods of data collection to ensure that the participants were representative of the hospital employees. However, although there were differences in the participants’ characteristics between the two methods of survey distribution, the overall baseline characteristics of participants and the distribution of main healthcare family groups were comparable with all HCWs in the hospital. The self-reported influenza vaccine uptake in this study was also similar to the vaccination rate measured by the hospital’s Occupational Health Clinic, which systematically maintains vaccination records for all hospital staff. Secondly, the study was a self-administered questionnaire with the outcome measures involving self-reported current vaccination status and intention for future vaccination, but not based on the actual vaccination records of staff. We also did not assess if the methods of data collection, either online or offline, affected the response of the participants. However, as the survey was self-administered and anonymous, and staff had voluntarily participated in the study, we believe that the responses were likely to be authentic with minimal social desirability bias. Thirdly, we did not measure the degree of participants’ exposure to the influenza campaign in the hospital or the media, and participants were not asked if they received a personal recommendation to receive the vaccine. This could be explored in future studies

to evaluate the effectiveness of the influenza vaccine campaign.

In conclusion, our study provided insights into the determinants for change in intention to receive seasonal influenza vaccination among HCWs in an Asian context. There were similarities and differences compared to known predictors of vaccine uptake and adherence, which could be context-specific. Older HCWs were more likely to maintain the status quo in behavior toward influenza vaccination. Medical HCWs were also divided into vaccine behavior with strong opposers and supporters of influenza vaccine. Perceived vaccine effectiveness and vaccine safety were important correlates of vaccine compliance and positive change in the intention for influenza vaccine. These findings should be used to guide future vaccination promotion campaigns, to increase HCWs' adherence to annual influenza vaccination.

### Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### ORCID

Dwee Wee Lim  <http://orcid.org/0000-0003-1160-4507>  
 Hanley J. Ho  <http://orcid.org/0000-0001-5247-1283>  
 Lay Tin Lee  <http://orcid.org/0000-0002-0602-2804>  
 Angela Chow  <http://orcid.org/0000-0002-4063-736X>  
 Win Mar Kyaw  <http://orcid.org/0000-0002-8135-2053>

### References

- Weber DJ, Orenstein W, Rutala WA. How to improve influenza vaccine coverage of healthcare personnel. *Isr J Health Policy Res.* 2016;5:61. doi:10.1186/s13584-016-0122-3.
- Centers for Disease Control and Prevention. Key facts about seasonal flu vaccine [Internet]. 2018 [Accessed 2018 Oct 18]. <https://www.cdc.gov/flu/protect/keyfacts.htm>
- Centers for disease control and prevention. Immunization of health-care personnel: recommendations of the Advisory Committee on Immunization Practices (ACIP) [Internet]. 2011 [Accessed 2017 Mar 14]. <https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6007a1.htm>
- Dini G, Toletone A, Sticchi L, Orsi A, Bragazzi NL, Durando P. Influenza vaccination in healthcare workers: a comprehensive critical appraisal of the literature. *Hum Vaccin Immunother.* 2017;14:772–89. doi:10.1080/21645515.2017.1348442.
- Osterholm MT, Kelley NS, Sommer A, Belongia EA. Efficacy and effectiveness of influenza vaccines: a systematic review and meta-analysis. *Lancet Infect Dis.* 2012;12:36–44. doi:10.1016/S1473-3099(11)70295-X.
- Burls A, Jordan R, Barton P, Olowokure B, Wake B, Albon E, Hawker J. Vaccinating healthcare workers against influenza to protect the vulnerable—is it a good use of healthcare resources? A systematic review of the evidence and an economic evaluation. *Vaccine.* 2006;24:4212–21. doi:10.1016/j.vaccine.2005.12.043.
- Nowak GJ, Sheedy K, Bursley K, Smith TM, Basket M. Promoting influenza vaccination: insights from a qualitative meta-analysis of 14 years of influenza-related communications research by U.S. Centers for Disease Control and Prevention (CDC). *Vaccine.* 2015;33:2741–56. doi:10.1016/j.vaccine.2015.04.064.
- Lim DW, Lee LT, Kyaw WM, Chow A. Psychosocial determinants of influenza vaccination intention: a cross-sectional study on inpatient nurses in Singapore. *Am J Infect Control.* 2017;45:e115–7. doi:10.1016/j.ajic.2017.03.017.
- Heinrich-Morrison K, McLellan S, McGinnes U, Carroll B, Watson K, Bass P, Worth LJ, Cheng AC. An effective strategy for influenza vaccination of healthcare workers in Australia: experience at a large health service without a mandatory policy. *BMC Infect Dis.* 2015;15:42. doi:10.1186/s12879-015-0765-7.
- Durando P, Alicino C, Dini G, Barberis I, Bagnasco AM, Iudici R, Zanini M, Martini M, Toletone A, Paganino C, et al. Determinants of adherence to seasonal influenza vaccination among healthcare workers from an Italian region: results from a cross-sectional study. *BMJ Open* [Internet] 2016 [cited 2018 Oct 11]; 6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4874132/>
- Lorenc T, Marshall D, Wright K, Sutcliffe K, Sowden A. Seasonal influenza vaccination of healthcare workers: systematic review of qualitative evidence. *BMC Health Serv Res* [Internet]. 2017; 17. [Accessed 2018 Oct 11]. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5688738/>
- Shahrabani S, Benzion U, Din GY. Factors affecting nurses' decision to get the flu vaccine. *Eur J Health Econ.* 2008;10:227–31. doi:10.1007/s10198-008-0124-3.
- Shahrabani S, Benzion U. How experience shapes health beliefs: the case of influenza vaccination. *Health Educ Behav.* 2012;39:612–19. doi:10.1177/1090198111427411.
- Lehmann BA, Ruitter RA, van Dam D, Wicker S, Kok G. Sociocognitive predictors of the intention of healthcare workers to receive the influenza vaccine in Belgian, Dutch and German hospital settings. *J Hosp Infect.* 2015;89:202–09. doi:10.1016/j.jhin.2014.11.009.
- Hollmeyer HG, Hayden F, Poland G, Buchholz U. Influenza vaccination of health care workers in hospitals—a review of studies on attitudes and predictors. *Vaccine.* 2009;27:3935–44. doi:10.1016/j.vaccine.2009.03.056.
- Kyaw WM, Chow A, Hein AA, Lee LT, Leo Y-S, Ho HJ. Factors influencing seasonal influenza vaccination uptake among health care workers in an adult tertiary care hospital in Singapore: a cross-sectional study. *Am J Infect Control* [Internet]. 2018; [Accessed 2018 Oct 18]. <https://www.ncbi.nlm.nih.gov/pubmed/30293741>
- Thoon KC, Chong CY. Survey of healthcare workers' attitudes, beliefs and willingness to receive the 2009 pandemic influenza A (H1N1) vaccine and the impact of educational campaigns. *Ann Acad Med Singap.* 2010;39:307–306.
- Castilla J, Martínez-Baz I, Godoy P, Toledo D, Astray J, García S, Mayoral JM, Martín V, González-Candelas F, Guevara M, et al. Trends in influenza vaccine coverage among primary healthcare workers in Spain, 2008–2011. *Prev Med.* 2013;57:206–11. doi:10.1016/j.ypmed.2013.05.021.
- Cavallante RDS, Jorge AMZ, Fortaleza CMCB. Predictors of adherence to influenza vaccination for healthcare workers from a teaching hospital: a study in the prepandemic era. *Rev Soc Bras Med Trop.* 2010;43:611–14. doi:10.1590/S0037-86822010000600001.
- Paula SID, Paula GID, Cunegundes KSA, Moraes-Pinto ID. Adherence to influenza vaccination among medical students during and after influenza A (H1N1) pandemic. *Revista do Instituto de Medicina Tropical de São Paulo* [Internet] 2016 [Accessed 2018 Oct 19]; 58. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5096636/>
- Tsutsui Y, Benzion U, Shahrabani S. Economic and behavioral factors in an individual's decision to take the influenza vaccination in Japan. *J Socio Econ.* 2012;41:594–602. doi:10.1016/j.socsc.2012.05.001.
- Tsutsui Y, Benzion U, Shahrabani S, Din GY. A policy to promote influenza vaccination: a behavioral economic approach. *Health Policy.* 2010;97:238–49. doi:10.1016/j.healthpol.2010.05.008.
- Zhang J, While AE, Norman IJ. Seasonal influenza vaccination knowledge, risk perception, health beliefs and vaccination

- behaviours of nurses. *Epidemiol Infect.* 2012;140:1569–77. doi:10.1017/S0950268811002214.
24. Rosenstock IM. The health belief model and preventive health behavior. *Health Educ Monogr.* 1974;2:354–86. doi:10.1177/109019817400200405.
  25. Nowalk MP, Lin CJ, Zimmerman RK, Fox DE, Raymund M, Tanis MD, Harper JD. Establish the habit: influenza vaccination for health care personnel. *J Healthc Qual.* 2010;32:35–42. doi:10.1111/j.1945-1474.2010.00073.x.
  26. Schmid P, Rauber D, Betsch C, Lidolt G, Denker M-L. Barriers of influenza vaccination intention and behavior - a systematic review of influenza vaccine hesitancy, 2005–2016. *PLoS One.* 2017;12:e0170550.
  27. Nyhan B, Reifler J. Does correcting myths about the flu vaccine work? An experimental evaluation of the effects of corrective information. *Vaccine.* 2015;33:459–64. doi:10.1016/j.vaccine.2014.11.017.
  28. Kim S, So J. How message fatigue toward health messages leads to ineffective persuasive outcomes: examining the mediating roles of reactance and inattention. *J Health Commun.* 2018;23:109–16. doi:10.1080/10810730.2017.1414900.
  29. So J, Alam N. Predictors and effects of anti-obesity message fatigue: a thought-listing analysis. *Health Commun.* 2019;34:755–763. doi: 10.1080/10410236.2018.1434736.
  30. Baseman JG, Revere D, Painter I, Toyoji M, Thiede H, Duchin J. Public health communications and alert fatigue. *BMC Health Serv Res.* 2013;13:295. doi:10.1186/1472-6963-13-295.
  31. Bollaerts K, Antoine J, Van Casteren V, Ducoffre G, Hens N, Quoilin S. Contribution of respiratory pathogens to influenza-like illness consultations. *Epidemiol Infect.* 2013;141:2196–204. doi:10.1017/S0950268812002506.
  32. Nowak GJ, Cacciatore MA, Len-Ríos ME. Understanding and increasing influenza vaccination acceptance: insights from a 2016 national survey of U.S. adults. *Int J Environ Res Public Health.* 2018;15. pii: E711. doi: 10.3390/ijerph15040711.
  33. Yeung MPS, Lam FLY, Coker R. Factors associated with the uptake of seasonal influenza vaccination in adults: a systematic review. *J Public Health (Oxf).* 2016;38:746–53. doi:10.1093/pubmed/fdv194.
  34. Sundaram N, Duckett K, Yung CF, Thoon KC, Sidharta S, Venkatachalam I, Chow A, Yoong J. “I wouldn’t really believe statistics” – challenges with influenza vaccine acceptance among healthcare workers in Singapore. *Vaccine.* 2018;36:1996–2004. doi:10.1016/j.vaccine.2018.02.102.
  35. Corace KM, Srigley JA, Hargadon DP, Yu D, MacDonald TK, Fabrigar LR, Garber GE. Using behavior change frameworks to improve healthcare worker influenza vaccination rates: a systematic review. *Vaccine.* 2016;34:3235–42. doi:10.1016/j.vaccine.2016.04.071.
  36. Lytras T, Kopsachilis F, Mouratidou E, Papamichail D, Bonovas S. Interventions to increase seasonal influenza vaccine coverage in healthcare workers: a systematic review and meta-regression analysis. *Hum Vaccin Immunother.* 2016;12:671–81. doi:10.1080/21645515.2015.1106656.
  37. Harrison N, Brand A, Forstner C, Tobudic S, Burgmann K, Burgmann H. Knowledge, risk perception and attitudes toward vaccination among Austrian health care workers: a cross-sectional study. *Hum Vaccin Immunother.* 2016;12:2459–63. doi:10.1080/21645515.2016.1168959.