

RESEARCH PAPER



Improved influenza vaccination coverage among health-care workers: evidence from a web-based survey in China, 2019/2020 season

Heya Yi^{a,*}, Yuan Yang^{b,*}, Li Zhang^c, Muli Zhang^b, Qing Wang^b, Ting Zhang^d, Yuyuan Zhang^a, Ying Qin^b, Zhibin Peng^b, Zhiwei Leng^d, Weizhong Yang^d, Jiandong Zheng^b, Xiaofeng Liang^a, and Luzhao Feng^d

^aDepartment of International Affairs, Chinese Preventive Medicine Association, Beijing, China; ^bDivision of Infectious Diseases, Chinese Center for Disease Control and Prevention, Beijing, China; ^cEditorial Department, BREATH-CIRCLES, Beijing, China; ^dSchool of Population Medicine and Public Health, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China

ABSTRACT

To understand influenza vaccination and its correlates among health-care workers (HCWs) during the 2019/2020 season in China, we used a self-administered electronic questionnaire to collect information on demographics, occupational characteristics, influenza vaccination status and access to free vaccination on the “Breath Circles”, a Chinese media platform for respiratory medical professionals. The reported influenza vaccine coverage among HCWs during this season was 67%, with more HCWs in a workplace with free vaccination than those with no free vaccination (79% vs. 34%, $p < .001$). The influenza vaccine coverage among HCWs who were required or encouraged to get vaccinated by the workplace was significantly higher than that without any intervention measures (80% & 70 vs. 39%, $p < .001$). The vaccine coverage in the workplaces with free and required vaccination simultaneously was highest compared to that with neither free vaccination nor any intervention measures (OR = 14.86, 95% CI: 10.93–20.20). The influenza vaccination coverage of HCWs in high-risk departments was significantly higher than that of other departments (70% vs. 58%, $p = .023$). HCWs’ vaccine coverage was related to personal opinions and attitudes toward influenza or influenza vaccines, as well as other constraints such as availability of influenza vaccines, workplace regulations, and access to free vaccines.

ARTICLE HISTORY

Received 21 July 2020
Revised 10 November 2020
Accepted 25 November 2020

KEYWORDS







Health-care workers;
influenza; influenza vaccines;
vaccination status

1. Introduction

Annual seasonal influenza epidemics result in substantial morbidity and mortality globally.¹ The Global Burden of Disease Study 2017 shows that 0.26% (95% CI: 0.20–0.32) of the global death toll can be attributed to influenza, with nearly one-third occurring in India, China and Russia.² In China, influenza was associated with an average of 2.5 excess influenza-like-illness (ILI) consultations per 1,000 person-years each year from 2006 to 2015³ and an annual mean of 88,100 influenza-associated excess respiratory deaths from 2010 to 2015.⁴ Due to occupational exposure, health-care workers (HCWs) have a greater chance to be infected with influenza virus, probably providing a source causing nosocomial transmission. A meta-analysis found that among all influenza-infected persons who were not vaccinated, the influenza incidence rate of HCWs was 18.7%, with a RR of 3.4 compared with people in other workplaces not associated with health care; among all symptomatic influenza-infected persons who were not vaccinated, the incidence rate of HCWs was 7.5, with a RR of 1.5.⁵ Influenza vaccination can not only prevent HCWs from influenza and its complications but

also reduce their absence from work.⁶ Furthermore, vaccination among HCWs can also indirectly protect vulnerable populations and high-risk patients in health-care facilities.⁷

China has made great efforts in pushing forward influenza vaccination coverage for HCWs. In October 2018, China National Health Commission issued an official document, requiring medical institutions at all levels to provide their staff with free influenza vaccination before influenza season and especially ensure that all HCWs in high-risk departments, such as respiratory or infectious diseases departments, were vaccinated.⁸ In the Technical Guidelines for Seasonal Influenza Vaccination in China (2019–2020), issued by the Chinese Center for Disease Control and Prevention, HCWs were the priority group for influenza vaccine.⁹ However, not all hospitals followed these documents well. The influenza vaccine coverage among HCWs was only 11.6% in China in 2018–2019.¹⁰ This study aims to investigate the influenza vaccination among HCWs during the 2019–2020 influenza season, to find out whether the strategies of free vaccination and workplace vaccination requirement are associated with higher influenza vaccination coverage in health-care settings, and to understand the attitudes of HCWs toward influenza vaccination.

CONTACT Zheng  zhengjd@chinacdc.cn  Division of Infectious Diseases, Chinese Center for Disease Control and Prevention, Beijing, China; Xiaofeng Liang  liangxf@cpma.org.cn  Department of International Affairs, Chinese Preventive Medicine Association, Beijing, China; Luzhao Feng  fengluzhao@cams.cn  School of Population Medicine and Public Health, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China.

*Heya Yi and Yuan Yang contributed equally to this work.

© 2021 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.

2. Materials and methods

2.1. Study design

A cross-sectional study was conducted among HCWs from April 9 to April 13, 2020, on the “Breath Circles” through a questionnaire survey powered by Wenjuanxing (wjx.cn). The “Breath Circles” is a WeChat-based media platform for respiratory medical professionals, covering 29 provincial regions in China with 154,000 subscribers who are working in various fields related to respiratory medicine, such as pneumology department, infectious diseases department, emergency department and pediatrics department. Wenjuanxing is a program for questionnaire designing with similar functions as Amazon Mechanical Turk. Previous studies have shown that years of work, departments of work, workplace regulations and access to free vaccination can be associated with influenza vaccine coverage.^{10–12} Besides, other researches have shown that the views of HCWs on the benefits, effectiveness, and side effects of influenza vaccine could affect their vaccine uptake.^{13,14} The content of our questionnaire includes occupations, work departments, influenza vaccination status, reasons for vaccination receipt/non-receipt, workplace regulation, vaccination policy, etc.

The sample size was estimated by the calculation formula of simple random samples, and the estimated sample size was 3,940 according to previous reported vaccination rate of 11.6% among HCWs,¹⁰ $\alpha = 0.05$, allowable error was 1%, and $Z\alpha = 1.96$. Considering the possible nonconforming feedback, the sample size should be at least 4,344, with a margin of 10%.

2.2. Data collection

We posted a questionnaire link on the Breath Circles, and all the survey items were compulsory. HCWs who received the link might forward it to their colleagues, but each participant could answer once. For certain questions, respondents can select more than one option with no rank order required.

We categorized respiratory department, infectious diseases department, emergency department, pediatrics department, intensive care unit (ICU)/intensive medicine department, fever clinic, geriatrics department, obstetrics and gynecology department as “high-risk departments”, with the remaining departments as “other departments”.⁸ Influenza vaccine coverage refers to the proportion of people who received influenza vaccine. Those who did not remember whether they had been vaccinated were excluded in the denominator when calculating the coverage.

We defined vaccination policy and workplace regulations on vaccination as follows: (1) The vaccination policy was divided into two types, namely free and self-pay. Free vaccination policy: the cost of vaccines and vaccination services is borne by the workplace, including payment by the workplace directly or the employee gets reimbursement after vaccination; Self-pay vaccination policy: the cost of vaccines and vaccination services is borne by the recipients. (2) Workplace regulations on vaccination were divided into four types, namely required, encouraged, no intervention, and unknown. Required vaccination: hospitals issued official document or regulation to ask employees to get compulsory vaccination;

Encouraged vaccination: hospitals motivated employees to receive influenza vaccine through the way of health education or health knowledge dissemination, e.g. influenza vaccine knowledge lectures or notice of time and place to get vaccinated; No intervention: hospitals neither required nor encouraged employees to get vaccinated; Unknown: respondents were not aware of any regulations on influenza vaccine in the workplace.

2.3. Statistics analysis

A new variable was created combining free vaccination policy and workplace regulation. This new variable was a categorical variable with 12 classes, namely no free policy with no intervention/encouragement/requirement/unknown, free policy with no intervention/encouragement/requirement/unknown, unknown whether it was free with no intervention/encouragement/requirement/unknown.

The survey results were imported into MS Excel and analyzed by SPSS and SAS. All the categorical variables were compared by using chi-square test ($\alpha = 0.05$). Binary logistic regression models were used to analyze the factors associated with the vaccination among HCWs. The dependent variable was whether vaccinated from August 2019 to April 2020. The independent variables were occupation, title, hospital level, department, GDP per capita, workplace regulations, free vaccination policy, and the new variable mentioned above.

2.4. Human subjects review

The study protocol and questionnaire were approved by the Ethical Review Committee of Chinese Center for Disease Control and Prevention (No.201901–01, China CDC, Beijing, China). All participants provided verbal informed consent to be interviewed.

3. Results

3.1. Demographics of study population

This survey collected 4,595 valid questionnaires, covering all the 29 provinces (autonomous regions, municipalities directly under the Central Government) in China. Among the 4,595 respondents, 1,667 (36%) worked in primary hospitals, 2,027 (44%) in secondary hospitals and 901 (20%) in tertiary hospitals; 3366 (73%) were in high-risk departments and 1129 (27%) were in other departments; 1332 (29%) were clinicians, 1283 (28%) were nurses, 1700 (37%) were medical technicians and 280 (6%) were of other categories.

3.2. Influenza vaccination status of HCWs and associated factors

Of the 4,595 respondents, 229 people did not remember whether they had been vaccinated against influenza during the period aforementioned. The vaccination coverage of this survey was 67% (2927/4366). Among these influenza vaccine recipients, 38.1% (1116/2927) received direct free vaccination, 30.2% (886/2927) got reimbursement from their workplace

after vaccination, 21.1% (618/2927) received self-paid vaccination 10.1% (297/2927) received health insurance reimbursement after vaccination, and 0.3% (10/2927) was other situations. The vaccination coverage of workplaces with free vaccination policy (79%) was significantly higher than that with no free vaccination policy (34%) ($p < .001$). Likewise, HCWs with workplace requirement (80%) or encouragement (70%) for vaccination had higher vaccination coverage than those without workplace requirement or encouragement (39%) ($p < .001$). The influenza vaccination coverage of HCWs in high-risk departments (70%) was significantly higher than that of other departments (58%) ($p = .023$). See Table 1 for details.

3.3. Correlates of influenza vaccination

The correlates of the influenza vaccination coverage were analyzed by binary logistic regression. HCWs' vaccination status was better when their workplace provided free vaccination policy (OR = 5.34, 95% CI: 4.49–6.34), required (OR = 2.81, 95% CI: 2.20–3.59) or encouraged influenza vaccination (OR = 1.95, 95% CI: 1.57–2.43). HCWs from high-risk departments (OR = 1.30, 95% CI: 1.10–1.53) had a higher coverage than those from other departments (Table 1). Taking HCWs from workplaces with no free vaccination policy and regulations as the reference group, that of free vaccination policy combined with vaccination requirement indicated the highest vaccination

coverage (OR = 14.86, 95% CI: 10.93–20.20), followed by the combination of free vaccination policy and encouraged vaccination (OR = 10.30, 95% CI: 7.74–13.71) (Table 2).

3.4. Reasons for influenza vaccination receipt/non-receipt

Among the 2,927 vaccinated HCWs, 65% worried about infecting others with influenza, 51% worried about catching influenza and 49% could access to influenza vaccine conveniently (Table 3). It is worth noting that 29% (964/3366) of HCWs from high-risk departments had not been vaccinated, which they mainly attributed to three causes: too busy in work (50%), influenza was not severe and it is not necessary to get vaccinated (41%), being worried about adverse reactions to influenza vaccine (36%) (Table 4).

4. Discussion

One year after China's National Health Commission released the official document, we saw a relatively high influenza vaccine coverage among HCWs during 2019/2020 season. Free vaccination policy combined with vaccination requirement was associated with a higher influenza vaccination coverage. Influenza vaccination can not only protect HCWs from influenza virus infection and help maintain the normal operation of health-care system but also reduce the risk of nosocomial

Table 1. Influenza vaccination coverage of 4366 HCWs in 2019/2020 influenza season.

Characteristic	Category	N	Vaccinated	Vaccination coverage (%)	P (chi-square test)	OR (95%CI)
Occupation	Clinicians	1292	783	61	0.16	Ref
	Nurse	1199	821	68		1.16 (0.95–1.40)
	Medical technicians ^a	1625	1177	72		1.22 (1.02–1.47)
	Others	250	146	58		1.00 (0.72–1.41)
Professional title ^b	Primary	743	484	65	0.27	Ref
	Middle	2506	1724	69		1.16 (0.95–1.42)
	Senior	1054	690	65		1.18 (0.94–1.49)
	Unknown	63	29	46		0.79 (0.43–1.44)
Hospital level ^c	Tertiary	867	559	64	<0.001	Ref
	Secondary	1918	1240	65		0.72 (0.59–0.87)
	Primary	1581	1128	71		0.93 (0.75–1.14)
Working departments	Others	1141	666	58	0.0023	Ref
	High-risk departments ^d	3225	2261	70		1.30 (1.10–1.53)
Province by GDP per capita ^e	Low	911	610	67	0.60	Ref
	Middle	1342	896	67		1.11 (0.91–1.36)
	High	2113	1421	67		1.06 (0.88–1.28)
Workplace's regulation	No intervention	583	225	39	<0.001	Ref
	Encourage	2320	1622	70		1.95 (1.57–2.43)
	Required ^f	1317	1055	80		2.81 (2.20–3.59)
	Unknown	146	25	17		0.53 (0.32–0.86)
Free vaccination	No	931	314	34	<0.001	Ref
	Yes	3229	2561	79		5.34 (4.49–6.34)
	Unknown	206	52	25		0.79 (0.55–1.14)

a: Medical technicians include inspection, imaging, ultrasound, electrocardiogram, pharmacy, etc. Others include scientific research, administration and logistics personnel.

b: Primary: equals to resident physician; Middle: equals to Chief physician; Senior: equals to Professor.

c: Primary hospitals: mainly refer to rural township hospitals and community health service centers that provide prevention, treatment, healthcare and rehabilitation services directly to communities of a certain population in China. Secondary hospitals: mainly refer to county-level hospitals that provide comprehensive medical and health-care services to multiple communities and undertake certain teaching and scientific research tasks. Tertiary hospitals: hospitals above the regional level that provides high-level specialized medical and health-care services and carries out higher education and scientific research tasks to multiple regions.

d: High-risk departments include respiratory department, infection department, emergency department, pediatrics department, ICU/intensive medicine department, fever clinic, geriatrics department, obstetrics and gynecology department.

e: In terms of GDP per capita, provinces are divided into three levels: low, middle and high. Low for Anhui, Qinghai, Jiangxi, Shanxi, Tibet, Heilongjiang, Guangxi, Guizhou, Yunnan, Gansu; Middle for: Chongqing, Shaanxi, Liaoning, Jilin, Ningxia, Hunan, Hainan, Henan, Xinjiang, Sichuan, Hebei; High for: Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang, Fujian, Guangdong, Shandong, Inner Mongolia, Hubei.

f: Required vaccination means hospitals issued official document or regulation to ask employees to get compulsory vaccination, but HCWs who have not received influenza vaccination will not be punished.

Table 2. Association between different interventions and HCWs' influenza vaccination status.

Free policy	Policy of workplace	N	Vaccinated	Coverage (%)	OR (95%CI)*
Yes	Require	1171	984	84.03	14.86 (10.93–20.20)
	Encourage	1835	1436	78.26	10.30 (7.74–13.71)
	No intervention	208	132	63.46	5.10 (3.47–7.48)
	Unknown	15	9	60.00	4.53 (1.55–13.21)
No	Require	129	64	49.61	2.92 (1.88–4.52)
	Encourage	409	158	38.63	1.87 (1.34–2.60)
	No intervention	314	79	25.16	Ref
	Unknown	79	13	16.46	0.60 (0.32–1.16)
Unknown	Require	17	7	41.18	2.04 (0.74–5.61)
	Encourage	76	28	36.84	1.77 (1.04–3.04)
	No intervention	61	14	22.95	0.88 (0.46–1.69)
	Unknown	52	3	5.77	0.18 (0.06–0.61)

* The independent variables of binary Logistic regression were occupation, title, hospital level, department, GDP per capita, and combination of workplace policy and regulations

Table 3. Reasons for influenza vaccination among health-careworkers in China, 2019–2020.

Reasons for vaccination*	N (2927)	Percentage (%)
Being worried that influenza will spread to others	1904	65
Being worried about having influenza	1505	51
Convenient vaccination site	1436	49
Required by the workplace	1235	42
Recommendations of the Guide 2019	1192	41
Free vaccination	754	26
Had influenza last winter	435	15
Influenza affects work	320	11

*These reasons are not mutually exclusive.

Table 4. Reasons for not getting influenza vaccination among health-careworkers in high-riskdepartments in China, 2019–2020.

Reasons for not being vaccinated*	N (964)	Percentage (%)
Too busy in work	479	50
Influenza won't cause severe illness	395	41
Being worried about adverse reactions	346	36
Do not know when to vaccinate	334	35
Influenza vaccine is not effective	319	33
Do not want to pay for the vaccine	313	32
Inconvenient vaccination site	260	27
Do not know where to vaccinate	215	22
Having contraindications	155	16
Pregnant or lactating women	76	8

*These reasons are not mutually exclusive.

infections and the spread of influenza that benefits those who have no access to vaccination. In 2017, 119 WHO countries and regions reported having influenza vaccines, and 102 countries reported having vaccination policies for HCWs.¹⁵ To reduce the morbidity and mortality of HCWs and patients related to influenza, and for fewer absences in number and duration, all HCWs without contraindications shall be vaccinated with influenza vaccine before the influenza season comes annually. Our research showed that the influenza vaccine coverage of HCWs in 2019/2020 influenza season was 67%. In the 2017/2018 influenza season, the influenza vaccination coverage among HCWs in the United States reached 78.4%.¹⁶ In the three influenza seasons from 2015 to 2018, the influenza vaccination coverage of HCWs in the 12 EU member states ranged from 15.6% to 63.2%.¹⁷

Other study indicates that appropriate policies might promote influenza vaccination coverage in a shortterm.¹⁸ In this survey, the vaccine coverage was higher in workplaces with free vaccination policy than those without free vaccination policy, and the coverage was higher when vaccination is required or encouraged by the workplaces. Besides, the result of logistic regression analysis showed that the combination of free vaccination policy and vaccination requirement was an effective strategy to promote vaccination coverage among HCWs. In the United States, the influenza vaccination coverage among HCWs was the highest (94.8%) when vaccination was required by workplaces and the lowest (47.6%) given no required, encouraged or provided on-site vaccination.¹⁶ Under the condition of free policy combined with high vaccine availability, the coverage among HCWs in Xining City, China, increased significantly.¹⁹

HCWs' vaccination behavior was related to the following aspects: complacency, convenience and confidence, such as physical availability, affordability and geographical accessibility and HCWs' attitudes toward influenza and influenza vaccines.²⁰ The top three reasons for HCWs to get vaccinated in this survey were being worried about infecting others, being worried about catching influenza, and being access to influenza vaccine conveniently. Our survey results also show that HCWs from high-risk departments were more likely to receive influenza vaccines than those from other departments. The reasons for this phenomenon might be influenza vaccine policymakers paid more attention to HCWs in high-risk departments than in other departments,⁸ or the HCWs from high-risk departments realized that they had greater exposure to influenza viruses.^{10,14} However, 29% of HCWs from high-risk departments remained unvaccinated, mainly because they were too busy. In the future, more measures need to be taken to promote influenza vaccination for this group.

In this study, 79% of HCWs showed a positive attitude toward influenza vaccination, and supported mandatory vaccination; 84% of HCWs said they agreed to compulsory influenza vaccination in workplace if they could be vaccinated for free. HCWs' attitude toward vaccine effectiveness and safety and their experiences of witnessing side effects of vaccination, immunization failure and vaccine pathogenicity are associated with their influenza vaccination-behavior.^{13,14,20} Therefore, future health education for HCWs should change their negative opinions and attitudes toward the influenza vaccine, promote them to recognize the risks of influenza scientifically, and enhance their confidence in influenza vaccination.

This study has limitations. Firstly, the survey can only represent the opinions of a certain percentage of HCWs and we do not know whether this part of the respondents are representative for overall HCWs in China. Secondly, 73% of respondents were HCWs from the defined high-risk departments who were more likely to receive the influenza vaccines, which may overestimate the influenza vaccination coverage. Thirdly, the vaccination status of HCWs in this study was self-reported, not based on the actual vaccination records of employees, and it may have recall bias. Finally, HCWs who saw the questionnaire link on WeChat may forward it to their colleagues, so it was difficult to calculate the response rate.

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

References

1. WHO. New global influenza strategy. [accessed 2020 Jun 10]. <https://www.who.int/news-room/detail/11-03-2019-who-launches-new-global-influenza-strategy>
2. GBD 2017 Influenza Collaborators. Mortality, morbidity, and hospitalisations due to influenza lower respiratory tract infections, 2017: an analysis for the global burden of disease study 2017. *Lancet Respir Med.* 2019 Jan; 7(1):69–89. doi:10.1016/S2213-2600(18)30496-X.
3. Feng L, Feng S, Chen T, Yang J, Lau YC, Peng Z, Li L, Wang X, Wong JYT, Qin Y, et al. Burden of influenza-associated outpatient-influenza-like illness consultations in China, 2006–2015: a population-based study. *Influenza Other Respir Viruses.* 2020;14(2):162–72. doi:10.1111/irv.12711.
4. Li L, Liu Y, Wu P, Peng Z, Wang X, Chen T, Wong JYT, Yang J, Bond HS, Wang L, et al. Influenza-associated excess respiratory mortality in China, 2010–15: a population-based study. *Lancet Public Health.* 2019;4(9):e473–e481. doi:10.1016/S2468-2667(19)30163-X.
5. Kuster SP, Shah PS, Coleman BL, Lam P-P, Tong A, Wormsbecker A, McGeer A. Incidence of influenza in healthy adults and healthcare workers: a systematic review and meta-analysis. *PLoS One.* 2011;6(10):e26239. doi:10.1371/journal.pone.0026239.
6. Imai C, Toizumi M, Hall L, Lambert S, Halton K, Merollini K. A systematic review and meta-analysis of the direct epidemiological and economic effects of seasonal influenza vaccination on healthcare workers. *PLoS One.* 2018;13(6):e0198685. doi:10.1371/journal.pone.0198685.
7. WHO. Vaccines against influenza WHO position paper – November 2012. *Wkly Epidemiol Rec.* 2012 Nov 23;87(47):461–76. English, French. PMID: 23210147.
8. China National Health Commission. National influenza prevention and control program (pilot version). [accessed 2020 Jun 15]. <http://www.nhc.gov.cn/jkj/s7923/201810/b30b71408e5641c7a166d4e389318103.shtml>
9. National Immunization Advisory Committee (NIAC) Technical Working Group (TWG), Influenza Vaccination TWG. Technical guidelines for seasonal influenza vaccination in China, 2019–2020. *Chin J Epidemiol.* 2019;40(11):1333–49. (in Chinese). doi:10.3760/cma.j.0254-6450.2019.11.002.
10. Liu H, Tan Y, Zhang M, Peng Z, Zheng J, Qin Y, Guo Z, Yao J, Pang F, Ma T, et al. An internet-based survey of influenza vaccination coverage in healthcare workers in China, 2018/2019 season. *Vaccines (Basel).*
11. To KW, Lai A, Lee KCK, Koh D, Lee SS. Increasing the coverage of influenza vaccination in healthcare workers: review of challenges and solutions. *J Hosp Infect.* 2016;94(2):133–42. doi:10.1016/j.jhin.2016.07.003.
12. Hussain H, McGeer A, Mcneil S, Katz K, Loeb M, Simor A, Powis J, Langley J, Muller M, Coleman BL, et al. Factors associated with influenza vaccination among health care workers in acute care hospitals in Canada. *Influenza Other Respir Viruses.* 2018;12(3):319–25. doi:10.1111/irv.12545.
13. Van DC, Van AM, Den IL, Bonten MJM, Sanders EA, Hak E. Attitude of Dutch hospital personnel towards influenza vaccination. *Vaccine.* 2008;26(10):1297–302. doi:10.1016/j.vaccine.2007.12.045.
14. Hagemester MH, Stock NK, Ludwig T, Heuschmann P, Vogel U. Self-reported influenza vaccination rates and attitudes towards vaccination among health care workers: results of a survey in a German university hospital. *Public Health.* 2018;154:102–09. doi:10.1016/j.puhe.2017.10.027.
15. Cherian T, Morales KF, Mantel C, Lambach P, Al Awaidy S, Bresee JS, Chunsuttiwat S, Coulibaly D, Feng L, Hale R, et al. Factors and considerations for establishing and improving seasonal influenza vaccination of health workers: report from a WHO meeting, January 16–17, Berlin, Germany. *Vaccine.* 2019;37(43):6255–61. doi:10.1016/j.vaccine.2019.07.079.
16. Black CL, Yue X, Ball SW, Fink RV, de Perio MA, Laney AS, Williams WW, Graitcer SB, Fiebelkorn AP, Lu P-J, et al. Influenza vaccination coverage among health care personnel – United States, 2017–18 influenza season. *Morbidity and Mortality Weekly Rep.* 2018;67(38):1050–54. doi:10.15585/mmwr.mm6738a2.
17. European Centre for Disease Prevention and Control. Seasonal influenza vaccination and antiviral use in EU/EEA Member States. [accessed 2020 Sep 13]. <https://www.ecdc.europa.eu/en/publications-data/seasonal-influenza-vaccination-antiviral-use-eu-eea-member-states>.
18. Feng L, Li Z. Analysis on immunization policy and key elements from countries with high influenza vaccination coverage. *Chin Prevent Med.* 2019;53:968–72.
19. Xu L, Zhao J, Peng Z, Ding X, Li Y, Zhang H, Feng H, Zheng J, Cao H, Ma B, et al. An exploratory study of influenza vaccination coverage in healthcare workers in a Western Chinese City, 2018–2019: improving target population coverage based on policy interventions. *Vaccines.* 2020;8(1):92. doi:10.3390/vaccines8010092.
20. MacDonald NE. SAGE working group on vaccine hesitancy. Vaccine hesitancy: definition, scope and determinants. *Vaccine.* 2015 Aug 14;33(34):4161–64. Epub 2015 Apr 17. PMID: 25896383. doi:10.1016/j.vaccine.2015.04.036.