Research letters

Awareness and practice of preventive measures among healthcare workers in medical institutions in Beijing during influenza season on the eve of COVID-19 epidemic: A cross-sectional survey

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Advances in Clinical and Experimental Medicine, ISSN 1899–5276 (print), ISSN 2451–2680 (online)

Adv Clin Exp Med. 2023;32(4):489–496

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Funding sources
None declared

Conflict of interest
None declared

Received on November 16, 2021
Reviewed on November 25, 2021
Accepted on September 28, 2022

Published online on November 30, 2022

Cite as
Xie ML, Zhang JX, Zhang ZY, Lin ZX. Awareness and practice of preventive measures among healthcare workers in medical institutions in Beijing during influenza season on the eve of COVID-19 epidemic: A cross-sectional survey. *Adv Clin Exp Med*. 2023;32(4):489–496. doi:10.17219/acem/154998

DOI
10.17219/acem/154998

Abstract

Background. Influenza is an acute respiratory infectious disease caused by the influenza virus, which poses a certain threat to humans due to its short incubation period, fast transmission and strong infectivity.

Objectives. To evaluate the awareness and prevention behavior against influenza among healthcare workers on the eve of the coronavirus disease 2019 (COVID-19) epidemic in Beijing, China.

Materials and methods. Using the cross-sectional research design based on the principle of convenience sampling, an online questionnaire survey on the knowledge of flu, vaccination, medical protection behavior, and flu medication was conducted between January and February 2020. Healthcare workers from different healthcare facilities and different job positions in Beijing participated in this survey.

Results. A total of 1910 healthcare workers from different medical institutions and jobs were included in the study. The mean age of the participants was 32.69 ±8.72 years (range: 18–64 years). There were significant differences in knowledge about clinical signs about flu and prevention approaches among different age groups, individuals with different work experience and job titles ($\chi^2 = 8.903–32.839$; $p < 0.05$). Personnel with different job positions and education levels differed only in the knowledge about clinical signs of flu and identification of high-risk populations. A multivariate logistic regression analysis revealed that age (odds ratio (OR) = 0.979, 95% confidence interval (95% CI): 0.966–0.992) and education level (OR = 0.736, 95% CI: 0.588–0.921) were risk factors for hand hygiene practices, whereas job position (OR = 1.757, 95% CI: 1.146–2.695) and awareness of high-risk populations (OR = 1.405, 95% CI: 1.096–1.800) were protective factors influencing hand hygiene practices ($p < 0.05$). The only factor influencing mask wearing was the education level (OR = 0.610, 95% CI: 0.450–0.828).

Conclusions. The knowledge level and preventive behavior of healthcare workers before the outbreak of COVID-19 has been insufficient.

Key words: influenza, awareness, healthcare workers, preventive measure

Introduction

Influenza (flu) is an acute respiratory infectious disease caused by the influenza virus, which poses a certain threat to humans due to its short incubation period, fast transmission and strong infectivity.[1] At present, non-pharmaceutical interventions (NPIs) are an effective influenza prevention and control measure because they are easy to implement and can be used to prevent the spread of flu.[2] The World Health Organization (WHO) released the Global Influenza Strategy 2019–2030, integrating NPIs into prevention and control programs as expanding policy and planning of seasonal influenza prevention and control to protect the vulnerable groups.[3] Similarly, over the last decade, scholars in China have considered the necessity of carrying out health education, timely vaccinations and relevant healthcare measures within the high-risk group to reduce the mortality risk from influenza-related diseases.[4]

Many countries and health institutions have been struggling to raise public awareness of and ability for influenza prevention and control vigorously. However, previous studies have shown that the public implementation of influenza prevention is still insufficient.[5,6] Due to the character of their work, healthcare workers have a high probability of contact with influenza patients compared with other professions. Healthcare workers' knowledge and protective ability are related to their safety and the health or awareness of every patient they contact. Understanding the current situation in medical personnel's prevention can provide important directions and ideas for medical institutions and the public to improve preventive measures in the future.

Objectives

This study was aimed to evaluate awareness and preventive behavior against influenza among healthcare workers on the eve of the coronavirus disease 2019 (COVID-19) epidemic in Beijing, China.

Materials and methods

Participants

Using the cross-sectional research design based on the principle of convenience sampling, an online questionnaire survey was conducted between January and February 2020. Healthcare workers from different healthcare facilities and different job positions in Beijing were included in this survey, including clinicians, nursing staff, medical technicians, and administrative or auxiliary staff. Subjects who studied or pursued further education in a healthcare facility in Beijing, and those who could not complete the survey due to technical difficulties, were excluded.

The study was approved by the Ethics Committee of Beijing Ditan Hospital, Capital Medical University, China (Approval No. 2020-046-02-A issued on February 21, 2021). Informed consent was obtained from all the subjects before participation in this study.

Survey tools

This survey was designed according to the results of on-site interviews with 10 frontline healthcare workers in healthcare facilities, relevant literature, and the content of related domestic and foreign flu awareness questionnaires. The questionnaire included questions concerning basic characteristics of the studied healthcare workers (job position, length of work experience in years, and living environment), their knowledge about flu (clinical signs of flu, high-risk populations, prevention, and treatment), flu vaccination and its reasons, their medical protection behavior (hand hygiene and wearing masks) during the flu season, and willingness to take flu medication.

The questionnaire contained 27 items, and all multiple-choice items were to be answered using a binary response (yes or no). Questions regarding basic characteristics of the healthcare workers were provided in a text form.

The reliability of the survey was evaluated and the questionnaire was revised through a pre-survey of a large sample which included 323 healthcare workers employed in the Beijing Ditan Hospital. The content of the survey was also validated by 5 experts with senior titles and more than 10 years of work experience in a related field (infectious diseases, pediatrics, nursing, and nosocomial infection). The final reliability and retest reliability of the questionnaire were indicated by Cronbach's $\alpha = 0.872$ and $r = 0.956$, respectively; the mean content validity index (CVI) of all items was 1 and the sampling validity was 90.8%. These scores indicated good reliability and validity for this study.

Survey methods

We used a convenience sampling method to explain the purpose and meaning of the study to the managers of healthcare facilities in Beijing. The managers were invited to send the online questionnaires to their employees who met the inclusion criteria. The survey was conducted anonymously.

Statistical analyses

The general data of the survey respondents were subjected to descriptive statistical analysis. The χ^2 test was applied to compare the differences between categorical variables. Binary logistic regression was employed to analyze the factors influencing the implementation of personal protective measures among healthcare workers. Hand hygiene and mask wearing are 2 very important such measures. Considering that there would be different influencing factors which restrict the implementation rate, we have performed univariable logistic and backward-stepwise logistic regression for these 2 dependent variables. Microsoft Excel 2016 (Microsoft Corporation, Redmond, USA) was used to record the data from the online questionnaire responses. This study did not employ interactive analysis, which is indeed a disadvantage, but we also believe that it should have no impact on the overall outcome. The likelihood ratio test was used for nested models to evaluate the global null hypothesis that 1 or more of the regression coefficients were equal to 0. The Hosmer–Lemeshow test was used to evaluate goodness-of-fit measures. The IBM SPSS v. 20.0 software (IBM Corp., Armonk, USA) was used to import the data and perform the statistical analysis, with $p < 0.05$ indicating statistical significance.

Results

Basic characteristics

Data were initially collected from 2002 healthcare workers. After excluding 8 nonlocal training subjects, 1994 healthcare workers from healthcare facilities in Beijing remained. As this study investigated and analyzed the situation in tertiary hospitals, 84 workers employed in primary and secondary healthcare facilities were excluded, leaving 1910 participants in the final analysis. The mean age of the participants was 32.69 ±8.72 years (range: 18–64 years). The general characterists of the participants including age, sex, job position, work experience in years, job title, education level, and type of hospital in which they work are shown in Table 1.

Table 1. Participant demographics

Index		Number	Percentage (%)
Age [years]	<30	823	43.1
	30–39	708	37.1
	40–49	274	14.3
	≥50	105	5.5
Sex	male	150	7.9
	female	1760	92.1
Job position	medical technician	169	8.8
	nursing staff	1741	91.2
Work experience [years]	<5	611	32
	5–10	517	27.1
	10–20	437	22.9
	>20	345	18.1
Job title	junior	1426	74.7
	intermediate	392	20.5
	senior	92	4.8
Education level	junior college and below	720	37.7
	undergraduate	1055	55.2
	graduate and above	135	7.1
Type of hospital	general	1711	89.6
	specialized	199	10.4

Awareness of flu preparedness in healthcare workers

The knowledge about flu among healthcare workers was assessed using 3 knowledge dimensions. It was measured using multiple-choice questions, and the selection was considered correct only if all options were selected. Answers were compared according to age, sex, job position, work experience (in years), job title, education level, and type of employing insitution. There were significant differences in the knowledge on clinical signs of flu and prevention approaches among different age groups, individuals with different work experience (in years), and persons with different job titles ($\chi^2 = 8.903–32.839$; $p < 0.05$). There were significant differences in the knowledge about high-risk populations of flu only among workers from different types of hospitals and holding different job titles.

The incidence of errors was high in those aged <30 years, whereas the correct answer rates in the older age groups were high ($\chi^2 = 12.877$; $p = 0.005$). The cognitive error rate was higher in the group with <5 years of work experience compared with other groups with more years of work experience ($\chi^2 = 10.113$; $p = 0.018$). The level about knowledge about the clinical signs of flu varied between workers with different job positions ($\chi^2 = 22.422$; $p < 0.001$). The correct answer rate of participants with higher education levels was higher compared with those with an education level of college or below ($\chi^2 = 29.296$; $p < 0.001$). There were significant differences in awareness of high-risk groups among participants from different levels of healthcare. ($\chi^2 = 6.976$; $p = 0.008$). Personnel with different job positions and education levels differed only in the knowledge about the clinical signs of flu and the identification of high-risk populations (Table 2).

Factors influencing flu preparedness in healthcare workers

The dependent variables included the practice of hand hygiene and mask wearing, while the independent variables included: age, sex, job position, work experience (in years), job title, education level, type of employing insitution, and awareness regarding the clinical signs of flu, high-risk populations and prevention approaches. Table 3 shows the assignment of each variable. The development of a multivariate logistic regression model was a two-step process. First, a univariate analysis was carried out to screen for independent variables. Multivariate logistic regression was then performed on statistically significant variables using a backward-stepwise method.

Table 2. Analysis of differences in answers to questions assessing knowledge about protective measures among 1910 medical workers

Index		Clinical manifestations, n (%)		High-risk population, n (%)		Prevention method, n (%)	
		correct	wrong	correct	wrong	correct	wrong
Age [years]	<30	384 (46.7)	439 (53.3)	581 (70.6)	242 (29.4)	574 (69.7)	249 (30.3)
	30–39	390 (55.1)	318 (44.9)	519 (73.4)	189 (26.6)	490 (69.3)	218 (30.7)
	40–49	145 (52.9)	129 (47.1)	194 (70.8)	80 (29.2)	154 (56.2)	120 (43.8)
	≥50	60 (57.1)	45 (42.9)	80 (76.2)	25 (23.8)	52 (49.5)	53 (50.5)
	χ^2	12.877		2.506		32.839	
	p-value	0.005*		0.474		<0.001*	
Sex	male	80 (53.3)	70 (46.7)	98 (65.3)	52 (34.7)	102 (68.0)	48 (32.0)
	female	899 (51.1)	861 (48.9)	1276 (72.5)	484 (27.5)	1168 (66.4)	592 (33.6)
	χ^2	0.281		3.517		0.166	
	p-value	0.596		0.061		0.684	
Job position	medical technician	116 (68.6)	53 (31.4)	120 (71.0)	49 (29.0)	113 (66.9)	56 (33.1)
	nursing staff	863 (49.6)	878 (50.4)	1254 (72.0)	487 (28.0)	1157 (66.5)	584 (33.5)
	χ^2	22.422		0.08		0.012	
	p-value	<0.001*		0.778		0.915	
Work experience [years]	<5	281 (46.0)	330 (54.0)	420 (68.7)	191 (31.3)	415 (67.9)	196 (32.1)
	5–10	276 (53.4)	241 (46.6)	384 (74.3)	133 (25.7)	369 (71.4)	148 (28.6)
	10–20	238 (54.5)	199 (45.5)	317 (72.5)	120 (27.5)	298 (68.2)	139 (31.8)
	>20	184 (53.3)	161 (46.7)	253 (73.3)	92 (26.7)	188 (54.5)	157 (45.5)
	χ^2	10.113		4.905		28.951	
	p-value	0.018*		0.179		<0.001*	
Job title	junior	711 (49.9)	715 (50.1)	1004 (70.4)	422 (29.6)	974 (68.3)	452 (31.7)
	intermediate	203 (51.8)	189 (48.2)	304 (77.6)	88 (22.4)	242 (61.7)	150 (38.3)
	senior	65 (70.7)	27 (29.3)	66 (71.7)	26 (28.3)	54 (58.7)	38 (41.3)
	χ^2	15.169		8.984		8.903	
	p-value	0.002*		0.03*		0.031*	
Education level	junior college and below	340 (47.2)	380 (52.8)	502 (69.7)	218 (30.3)	464 (64.4)	256 (35.6)
	undergraduate	541 (51.3)	514 (48.7)	775 (73.5)	280 (26.5)	718 (68.1)	337 (31.9)
	graduate and above	98 (72.6)	37 (27.4)	97 (71.9)	38 (28.1)	88 (65.2)	47 (34.8)
	χ^2	29.296		3.004		5.346	
	p-value	<0.001*		0.391		0.148	
Type of hospital	general	867 (50.7)	844 (49.3)	1215 (71.0)	496 (29.0)	1127 (65.9)	584 (34.1)
	specialized	112 (56.3)	87 (43.7)	159 (79.9)	40 (20.1)	143 (71.9)	56 (28.1)
	χ^2	2.245		6.976		2.872	
	p-value	0.134		0.008*		0.090	

* $p < 0.05$

The univariable logistic regression model showed that the risk factors associated with hand hygiene were: age, job position, work experience, job title, education level, and awareness of high-risk populations (Table 4). In univariable logistic regression model of mask wearing, the risk factors were: age, job position, work experience, job title, education level, type of employing insitution, awareness of high-risk populations, and awareness of prevention approaches (Table 5).

In the multivariable logistic regression model of hand hygiene practices, age (odds ratio (OR) = 0.979, 95% confidence interval (95% CI): 0.966–0.992) and education level (OR = 0.736, 95% CI: 0.588–0.921) were risk factors, whereas job position (OR = 1.757, 95% CI: 1.146–2.695) and awareness of high-risk populations (OR = 1.405, 95% CI: 1.096–1.800) were preventive factors ($p < 0.05$, R^2 Nagelkerke: 0.049) (Table 6). Testing the global null hypothesis for regression coefficients equal to 0 indicated that these factors could predict the outcome. According to the Hosmer–Lemeshow test, the model is well-fitted (p = 0.856).

In the multivariable logistic regression model of mask wearing, age (OR = 0.95; 95% CI: 0.935–0.966) and education level (OR = 0.57; 95% CI: 0.452–0.720) were risk factors, and the awareness of high-risk populations (OR = 1.469;

Table 3. Variables and assignments for multivariate logistic regression

Variable	Assignment
Hand hygiene practices	0 – no, 1 – yes
Wearing masks	0 – no, 1 – yes
Age [years]	1 – <30 2 – 30–39 3 – 40–49 4 – ≥50
Sex	1 – male, 2 – female
Job position	1 – medical technician, 2 – nursing staff
Job title	1 – primary, 2 – secondary, 3 – tertiary
Education level	1 – junior college and below, 2 – undergraduate, 3 – graduate and above
Type of hospital	1 – general, 2 – specialized
Awareness of clinical signs of flu	0 – wrong, 1 – correct
Awareness of high-risk populations	0 – wrong, 1 – correct
Awareness of prevention approaches	0 – wrong, 1 – correct

95% CI: 1.076–2.006) was a preventive factor for mask wearing practices ($p < 0.05$, R^2 Nagelkerke: 0.075) (Table 7). The result of likelihood ratio test was $p < 0.001$; therefore, the null hypothesis of regression coefficient equaling 0 was rejected. However, according to the Hosmer–Lemeshow test, the overall model fit was poor ($p = 0.046$).

Discussion

During an epidemic of infectious respiratory diseases, prevention is crucial for healthcare workers, not only to protect their health but also to ensure the safety of patients and related populations. Due to their daily interaction with sick people in general, and especially those with influenza, healthcare workers are at a higher risk of infection,[8] and are also more likely to transmit influenza virus, especially as they can be asymptomatic carriers.[9–13]

In this survey, 3 main knowledge dimensions of flu were examined, namely clinical signs, high-risk populations

Table 4. Univariate logistic regression results of factors influencing preparedness capabilities of hand hygiene

Variables	B	SE	Wald	p-value	OR	EXP(B) 95% CI		R^2 Nagelkerke	p-value of likelihood-ratio test
						lower limit	upper limit		
Age	−0.026	0.006	−4.140	<0.001	0.974	0.962	0.986	0.014	<0.001
Sex	0.146	0.206	0.707	0.480	1.157	0.773	1.732	<0.001	0.487
Job position	1.008	0.173	5.827	<0.001	2.741	1.953	3.847	0.027	<0.001
Work experience [years]	−0.147	0.052	−2.820	0.005	0.863	0.779	0.956	0.007	0.005
Job title	−0.417	0.083	−5.015	<0.001	0.659	0.560	0.776	0.020	<0.001
Education level	−0.503	0.094	−5.328	<0.001	0.605	0.502	0.728	0.024	<0.001
Type of hospital	−0.316	0.176	−1.802	0.072	0.729	0.517	1.028	0.003	0.078
Awareness of clinical signs of influenza	0.142	0.115	1.235	0.217	1.152	0.920	1.444	0.001	0.217
Awareness of high-risk populations	0.344	0.123	2.794	0.005	1.411	1.108	1.795	0.006	0.006
Awareness of prevention approaches	0.078	0.121	0.650	0.516	1.082	0.854	1.370	<0.001	0.517

95% CI – 95% confidence interval; OR – odds ratio; SE – standard error; EXP(B) – exponential function of B.

Table 5. Univariate logistic regression results of factors influencing preparedness capabilities of mask wearing

Variables	B	SE	Wald	p-value	OR	EXP(B) 95% CI		R^2 Nagelkerke	p-value of likelihood-ratio test
						lower limit	upper limit		
Age	−0.051	0.008	−6.656	<0.001	0.950	0.936	0.965	0.044	<0.001
Sex	0.164	0.257	0.636	0.525	1.178	0.711	1.949	<0.001	0.532
Job position	0.929	0.205	4.535	<0.001	2.532	1.695	3.784	0.019	<0.001
Work experience [years]	−0.416	0.067	−6.179	<0.001	0.660	0.578	0.753	0.041	<0.001
Job title	−0.615	0.094	−6.518	<0.001	0.541	0.450	0.651	0.039	<0.001
Education level	−0.627	0.120	−5.214	<0.001	0.534	0.422	0.676	0.029	<0.001
Type of hospital	−0.532	0.206	−2.576	0.010	0.588	0.392	0.881	0.006	0.014
Awareness of clinical signs of influenza	0.142	0.146	0.971	0.332	1.152	0.866	1.533	0.001	0.332
Awareness of high-risk populations	0.361	0.154	2.343	0.019	1.435	1.061	1.940	0.006	0.021
Awareness of prevention approaches	0.321	0.149	2.148	0.032	1.378	1.028	1.847	0.005	0.033

95% CI – 95% confidence interval; OR – odds ratio; SE – standard error; EXP(B) – exponential function of B.

Table 6. Multivariate logistic regression results of factors influencing preparedness capabilities of hand hygiene

Variables in the equation in step 1	B	SE	Wald	df	p-value	OR	EXP(B) 95% CI	
							lower limit	upper limit
Age	–0.021	0.007	9.604	1	0.002	0.979	0.966	0.992
Job position	0.564	0.218	6.675	1	0.010	1.757	1.146	2.695
Education level	–0.307	0.115	7.159	1	0.007	0.736	0.588	0.921
Awareness of clinical signs of influenza	0.221	0.120	3.420	1	0.064	1.247	0.987	1.577
Awareness of high-risk populations	0.340	0.126	7.223	1	0.007	1.405	1.096	1.800
Constant	1.509	0.719	4.407	1	0.036	4.524	–	–

df – degrees of freedom; 95% CI – 95% confidence interval; OR – odds ratio; SE – standard error; EXP(B) – exponential function of B.

Table 7. Multivariate logistic regression results of factors influencing preparedness capabilities of mask wearing

Variables in the equation in step 1	B	SE	Wald	df	p-value	OR	EXP(B) 95% CI	
							lower limit	upper limit
Age	–0.051	0.008	–6.274	1	0.000	0.950	0.935	0.966
Education level	–0.562	0.119	–4.715	1	0.000	0.570	0.452	0.720
Awareness of clinical signs of influenza	0.238	0.152	1.571	1	0.116	1.269	0.943	1.708
Awareness of high-risk populations	0.385	0.159	2.420	1	0.016	1.469	1.076	2.006
Constant	4.992	0.445	11.207	1	0.000	147.229	61.496	352.483

df – degrees of freedom; 95% CI – 95% confidence interval; OR – odds ratio; SE – standard error; EXP(B) – exponential function of B.

and prevention approaches. The awareness rates for high-risk populations and prevention approaches were relatively high. However, in terms of the awareness of clinical signs, only 16.65% of the participants answered correctly for the item "do not have symptoms of a common cold", 72.61% of the participants answered correctly for "also have gastrointestinal symptoms such as vomiting, abdominal pain and diarrhea", and the rate was from 92.48% to 97.22% for other items. This indicated that there was a confusion about the clinical signs of flu even among healthcare workers. Although the National Health Commission of the People's Republic of China issued the Guidelines for the Diagnosis and Treatment of Flu in 2011 and updated it in 2018,[14] after nearly a decade, the level of awareness of flu among healthcare workers remains low and needs to be improved through organizational training.

In the analysis of demographic factors, there were statistical differences in the perception of clinical representations of influenza by age, job position, work experience, job title, education level, and type of employing insitution. The cognitive error rate was higher in the group with <5 years of work experience compared to other groups with more years of work experience. It was because healthcare workers with longer work experience had more training opportunities during their clinical practice. The level of knowledge about the clinical signs of flu varied between job positions, with the higher correct answer rates among clinicians and medical technicians compared to the nursing staff, which could be attributed to their participation in the diagnosis, treatment and administration of medication, as these require a higher level of knowledge. The healthcare workers with education levels of college or below were mainly nursing staff (90.69%), suggesting that the nursing staff needed to improve their knowledge on the clinical signs of flu. Regarding the question on who was at a high risk of flu, there were differences in the responses based on the type of employing insitution. Respondents from specialized hospitals had a higher correct answer rate than healthcare workers from general hospitals. This may be because the specialized hospital in question is predominantly an infectious disease hospital, where the healthcare workers are more knowledgeable about flu. Finally, the differences in responses to prevention approaches were mainly related to age and job title. The results indicated that healthcare workers <30 years of age and junior staff were more likely to be correct regarding this item than other groups, as the concept of "post-exposure prophylaxis" was more accepted among young population because it received more emphasis during their education.

In this study, all healthcare workers believed that they practiced hand hygiene properly, indicating that the overall hand hygiene and mask wearing practices among the healthcare workers were satisfactory. The "Five Moments for Hand Hygiene" advocated by the World Health Organization (WHO) were developed for the hospital setting and may require some adaptation before the implementation in the primary care context,[15] considering that hand hygiene, if done properly, can reduce the transmission of influenza.[16] However, the survey results showed that 8 staff members did not wear masks during the flu season. All of them were women aged 22–54 years. The 8 interviewed staff members (1 nurse and 7 doctors) worked in different types of hospitals (general hospitals or specialized hospitals). Although these 8 people accounted for a small proportion of the 1910 respondents, it indicates some inadequacies in the infection prevention in healthcare facilities and implies that there are still problems in the preparedness of healthcare workers in general hospitals that need attention and better management. The factors influencing hand hygiene practices included age, education level, job position, and the number of correct answers about high-risk populations; older age and higher education were related to less meticulous hand hygiene practices. This may be attributed to the low compliance with hand hygiene practices in older people, while habitual thinking patterns and years of taking potluck lead to poor hand hygiene practices in more educated teams of doctors. The factors influencing mask wearing were age, education level and awareness of high-risk populations. Higher educated individuals showed a poorer rate of the mask wearing. This may also be related to the lack of awareness regarding the importance of wearing masks among the higher-educated staff. Therefore, it is crucial to enhance the education and supervision of healthcare workers, especially physicians, during the implementation of protective measures. However, this result differs from previous findings in different knowledge levels, where the high level of awareness shown by the physician community did not guide the clinical practice of self-protection, which suggests that there might be a need to explore the relationships among knowledge, beliefs and actions.

Therefore, while supervising healthcare workers and guiding them in self-protection and management of facilities, training should be provided and emphasis should be put on finding strategies to enhance their knowledge to promote the standardized implementation of protective measures. Moreover, it is recommended to use distance learning techniques to provide layered training tailored to the healthcare workers' needs in order to minimize knowledge gaps, reduce misunderstandings, improve knowledge, and ultimately achieve the goal of improving the overall protection capabilities.

Limitations

There were also some limitations to this study. Our study used convenience sampling, which inevitably resulted in bias. Moreover, this survey did not include other levels of healthcare facilities, resulting in incomplete information on the overall awareness and implementation of prevention among healthcare workers in the region. However, the results of the survey conducted among healthcare workers in tertiary healthcare facilities may also provide insights and reflections for relevant departments, which may be of a great practical significance. Future research should explore strategies for improvements in a larger population. In the results of logistic regression, we found that R^2 Nagelkerke was very low ($p < 0.01$), indicating that the variation in the outcome variable cannot be explained based on the variables selected from the survey of this study. Therefore, there is still a need to explore more desirable variables in further studies.

Conclusions

Influenza prevention education in various regions of China has been effective among the public during the influenza epidemic. Although these educational programs were effective, our study showed that healthcare workers still performed poorly at the implementation of prevention strategies. In the future, continuous attention should be paid to improving the preparedness ability and awareness of healthcare workers. Especially under the impact of the COVID-19 pandemic, substantial changes will be possible.

Data availability statement

All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

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