Influenza vaccination uptake among public primary healthcare workers in Seberang Perai Tengah district, Penang

Ling Jih Ming, MBBS[1,2], Noorlaili Mohd Tohit, PhD[1], Yusmawati Mohd Yusof, MMed[2], Syahnaz Mohd Hashim, PhD[1], Ng Li Yun, MD[3]

[1]Department of Family Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, [2]Klinik Kesihatan Bandar Perda, Ministry of Health Malaysia, Pulau Pinang, Malaysia, [3]Clinical Research Centre, Seberang Jaya Hospital, Ministry of Health Malaysia, Pulau Pinang, Malaysia

ABSTRACT

Introduction: Influenza poses a significant public health burden globally, contributing to substantial morbidity and mortality, particularly among vulnerable populations. Healthcare workers (HCWs) are at increased risk of contracting and transmitting influenza, making vaccination a key preventive strategy. Despite the well-established benefits and strong recommendations advocating influenza vaccination for all HCWs, only a few studies have examined vaccination uptake among HCWs in Malaysia. This study aimed to determine the prevalence of influenza vaccination among public primary HCWs in Seberang Perai Tengah district, Penang, reasons for vaccination or non- vaccination and to identify its associated factors.

Material and Methods: A cross-sectional study was conducted from January to March 2025 inviting all HCWs from nine health clinics and six dental clinics in the district. Data for socio-demography, work-related characteristics, history of influenza vaccination, reason to vaccinate or non-vaccination for influenza, knowledge and attitude towards influenza and its vaccination were collected using a validated self-administered questionnaire in a Google form. Knowledge and attitudes towards influenza and its vaccination were assessed using an 18-item questionnaire on a five-point Likert scale. A higher score for each component, knowledge (0-15) and attitude (0-3), indicates better knowledge and more positive attitudes, respectively. Descriptive statistics were used for demographic data and prevalence. Multiple logistic regression was performed to identify factors associated with vaccination uptake.

Results: A total of 359 HCWs participated. The participants had a mean age of 37.9 years (SD=7.09), with females comprising 77.7% of the sample. Nurses represented the largest proportion (33.7%), followed by assistant or aide (24.2%), and doctors (11.7%). The prevalence of influenza vaccination uptake was 97%, with only 12 participants reported never being vaccinated. The primary reasons for vaccination were self-protection (94.2%), followed by protecting family and friends (70.9%) and the availability of free vaccination at work (50.7%). Among the unvaccinated participants, 58.3% expressed concerns about side effects and 25% stated reasons for fear of getting sick from the vaccine and personal reluctance. Multiple logistic regression revealed that the attitude score was significantly associated with influenza vaccination uptake (Adjusted OR: 2.12, 95% CI: 1.30-3.44, p=0.002). Vaccinated participants had a higher median knowledge score (11.0, IQR 4.00), and attitude score (3.0, IQR 1.00) compared to non-vaccinated participants suggesting better knowledge and attitude towards influenza or its vaccinations. While most participants held positive views, misconceptions persisted; 30.4% believed the vaccine might cause influenza, and 39.3% believed influenza could be transmitted via blood.

Conclusion: The high vaccination rate reflects strong acceptance and awareness among HCWs. Misconceptions regarding vaccine safety persist, and necessitate targeted educational efforts. Although high uptake suggests favourable attitudes, further longitudinal studies are needed to explore motivational factors and causality more definitely. Targeted education can address misconceptions and side effects, supporting sustained high vaccination rates and reducing hesitancy.

KEYWORDS:
Influenza, vaccination, primary healthcare, healthcare workers, Malaysia

INTRODUCTION

Seasonal influenza affects around one billion cases annually, including 3-5 million severe cases and causes 290,000 to 650,000 respiratory deaths worldwide.[1] During influenza pandemics, the emergence of novel, rapidly evolving strains resulted in millions of deaths worldwide, with multiple strains often circulating concurrently.[2] This acute viral respiratory infection contributes to substantial morbidity and mortality each year, particularly among older adults.[3] Consequently, vaccination is a key component of pandemic preparedness, safeguarding HCWs and ensuring the continuity of essential health services during outbreaks. According to the Centers for Disease Control and Prevention, individuals aged 65 and above account for 50-70% of influenza-related hospitalisations and 70-85% of influenza-related deaths.[4]

Influenza is caused by RNA viruses of the Orthomyxoviridae family, with three main subtypes: A, B, and C.[5] Influenza type A and B cause seasonal epidemics. Typical symptoms

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Corresponding Author: Noorlaili Mohd Tohit
Email: laili@hctm.ukm.edu.my

include fever, cough, sore throat, headache, myalgia, malaise and coryza. In Malaysia, influenza occurs throughout the year as indicated by WHO bi-weekly influenza update.[6] It should not be mistaken for the common cold, as it may lead to complications such as bronchitis, pneumonia, sinusitis, otitis media, encephalitis, pericarditis, and Reye's syndrome.[7] Transmission primarily occurs through respiratory droplets and aerosols. The incubation period ranges from one to four days. Individuals may be infectious from one day before symptom onset to up to seven days thereafter.[7]

Uncomplicated influenza is generally self-limiting and managed with supportive care, including antipyretics and hydration. However, complications involving the lower respiratory tract may require hospitalisation, further straining healthcare resources. HCWs are at elevated risk of contracting and transmitting influenza due to occupational exposure.[8] Primary healthcare providers, as the initial point of patient contact, are particularly crucial in breaking the chain of transmission and safeguarding high-risk populations.[9]

Globally, influenza vaccination uptake among HCWs varies considerably. A recent meta-analysis included data from 26 countries, reporting an overall HCWs vaccination uptake of 41.7%.[10] A more detailed breakdown revealed regional vaccination coverage was highest in the Americas at 67.1%, followed by the Middle East at 51.3%, Oceania at 48.7%, Europe at 42.5%, Asia at 28.5%, and lowest in Africa at 6.5%.[10] Despite the availability of free influenza vaccinations for public HCWs in Malaysia, its uptake remains suboptimal, ranging from 7.2%-67.2%.[9,11-13] A study conducted in local university reported a declining trend in influenza vaccination uptake: 23.8% in 2009, 18.8% in 2010, and 7.2% in 2011.[12] The highest reported rate of 67.2% vaccination uptake was among primary HCWs in Klang Valley, Malaysia, following influenza A H1N1 pandemic in 2009.[9] At post COVID-19 pandemic era, we would expect a higher acceptance of vaccination among HCWs as part of preventive effort.

A study carried out among HCWs in Turkey found that the primary reason for receiving the influenza vaccine was "to protect myself and my family".[14] The main reasons cited for non-vaccination included the belief that "Influenza vaccination is unnecessary and ineffective", as well as past experiences with the vaccine.[14] Similarly, a local study reported that protection against influenza infection was the most common motivator for vaccination, while time constraints were the most frequently cited barrier.[12] Their study also found that influenza vaccination uptake was significantly associated with older age and a history of previous vaccination.[12] In another study in Saudi Arabia, the perception of being at own risk was seen as a major deterrent to vaccination.[15] Factors associated with vaccine uptake in their study included prior vaccination and availability of the vaccine in the workplace.[15]

Influenza vaccination is primarily administered via intramuscular injection. However, an alternative option is intranasal live attenuated influenza vaccine (LAIV), which may be suitable for specific populations, such as healthy and non-pregnant individuals aged 2-49 years.[16] This limits LAIV's utility in mass vaccination campaigns. In Malaysia, various inactivated influenza vaccines are available, including egg-based quadrivalent vaccines such as Fluarix Tetra, Influvac, FluQuadri Quadrivalent, Vaxigrip Tetra, as well as cell-based vaccine such as SKYCellflu Quadrivalent.[17] Malaysia does not include the live attenuated influenza vaccine in the national immunisation program.

Influenza vaccination provides protection to approximately 54% to 67% of the vaccinated population for up to 12 months.[18] Though adverse effects such as local pain, fever, malaise and irritability are common, the benefits outweigh the risks.[19] Rare but serious side effects, such as anaphylaxis, Guillain-Barre syndrome, and pericarditis, have been reported but occur infrequently. Scientific evidence supports the safety and efficacy of influenza vaccination.[20]

According to the Malaysian guidelines for adult immunisation, the annual influenza vaccine is recommended for all individuals wishing to reduce their risk and for specific target groups. These include HCWs, individuals aged 50 and above, those aged 18-49 with underlying medical conditions, pregnant women, individuals living in institutional settings, and persons with obesity.[17] Other high-risk groups include immunocompromised individuals, such as those with HIV, those undergoing chemotherapy or corticosteroid therapy, and patients with malignancy.[1]

This study aimed to determine the prevalence of influenza vaccination uptake among public primary HCWs in Seberang Perai Tengah District, Penang, reasons for accepting or refusing vaccination and to identify factors associated with vaccine acceptance.

MATERIALS AND METHODS

A cross-sectional study was conducted from January to March 2025 involving HCWs from all fifteen public primary care clinics consisting of nine health clinics and six dental clinics in Seberang Perai Tengah district of Penang, Malaysia. All HCWs in the fifteen public primary care clinics in Seberang Perai Tengah district were invited to participate in the study. Recruitment was coordinated by the Family Medicine Specialist in each respective clinic, who disseminated the invitation message through their clinic's official WhatsApp group. A participant information sheet, informed consent and a self-administered questionnaire were disseminated via a Google forms link. A follow-up reminder was sent two weeks after the initial distribution for two rounds.

Participants were required to log in with a unique Google account to avoid duplicate responses. Data were manually reviewed to check for completion, inconsistency or suspicious entry. The inclusion criteria encompassed all HCWs who could comprehend either in English or Malay and provided informed consent. Cleaners were excluded from participation as they were outsourced from private companies. A total of 982 HCWs were invited, and 360 responded, yielding a response rate of 36.6%. However, one participant was excluded due to contradictory responses, resulting in 359 participants for further analysis.

For objective 1 prevalence estimation, sample size calculation was performed using the population proportion formula,[21] based on a previous estimated vaccination prevalence of 51.4% among HCWs.[11] The population size was 982 (the total number of HCWs in Seberang Perai Tengah in March 2025). The calculation assumed a Type 1 error probability of 0.05 and precision of 0.05. The calculated sample size was 277 samples. Accounting for a 20% potential dropout rate, the minimum required sample size was 347.

For objective 2 risk factor analysis, sample size was calculated using G*Power software for logistic regression analysis. To detect a predictor with a large effect size (odds ratio=12.49)[12], with 80% power, 5% significance level, and baseline complication prevalence of 7.2%, the minimum required sample size was 51 participants after accounting for covariates.

The final sample size of 347 participants was chosen as it provides adequate power for both objectives, ensuring robust analysis for prevalence estimation and sufficient power to detect clinically meaningful risk factors.

Study Instrument

This study utilised a self-administered questionnaire adapted with permission from an instrument developed and validated by Hudu et al. for use among Malaysian healthcare workers.[11] The choice of this instrument was based on its established validity and relevance to our target population. The original validation by Hudu et al. included a pilot survey with HCWs in Malaysia, which affirmed its content validity and linguistic appropriateness for the local context.[11] For our study, the questionnaire was deployed via Google Forms and was pre-tested by a small group of primary care HCWs for clarity and technical functionality. The questionnaire comprises of 33 questions across six key domains: i) socio-demographic data, ii) work-related characteristics, iii) history of influenza vaccination, iv) reason for vaccination or non-vaccination, v) knowledge and attitude towards influenza and its vaccination, and vi) presence of comorbidities associated with increased influenza risk.[11]

Knowledge and attitude related to influenza and its vaccination were assessed using 18-item questions originally developed by Hudu et al.[11] For our study, the scale demonstrated good internal consistency with a Cronbach's alpha of 0.91. Each statement was assessed using a five-point Likert scale, ranging from "Strongly agree to Strongly disagree". Responses were scored as follows: *1-strongly agree, 2- agree, 3-not sure, 4- disagree, 5- strongly disagree*. We simplified the scoring into dichotomization as most statements assessed factual knowledge. For positively worded statements, "Strongly agree" or "Agree" responses were scored as 1, while "Not sure", "Disagree" and "Strongly disagree" were scored as 0. Items 12,14,17 were reverse- coded to ensure that a higher total score consistently reflected better knowledge and more positive attitudes toward influenza and its vaccination. Knowledge-related items included Q1-Q7 and Q11-Q18, while attitude-related items were Q8-Q10. There were no missing data points among the participants in this study.

Ethical Consideration

This study was approved by Medical Research and Ethics Committee (MREC) of the Ministry of Health Malaysia (NMRR ID-24-02381-TQE) and the Research Ethics Committee of University Kebangsaan Malaysia (UKM) (JEP-2024-589). Permissions were obtained from Penang State Health Department (JKN Pulau Pinang), Seberang Perai Tengah District Health Office (PKD), and Seberang Perai Tengah Dental Health Office (PPD) prior to study commencement. All participants provided informed consent before answering the questionnaire. Participation was voluntary, and confidentiality was assured throughout the study. The questionnaires used in this study was adapted with permission from the original authors.[11]

Statistical Analysis

Data entry and analysis were conducted using IBM SPSS Statistics version 26. Prior to analysis, data cleaning was performed to check for any missing values, data entry errors, or inconsistencies. Categorical variables were presented as frequencies and percentages, whereas continuous variables were described using means and standard deviations (SD) for normally distributed data or medians with interquartile ranges (IQR) for skewed data.

The prevalence of influenza vaccination uptake among the HCWs was calculated and expressed as a percentage. Reasons for receiving or not receiving the influenza vaccination were presented in frequency tables. To assess knowledge and attitude, two separate scores were calculated from the 18-item Likert-scale questionnaire. A knowledge score was derived from 15 specific questions (possible range: 0-15), while a distinct attitude score was derived from the remaining three questions (possible range: 0-3). Each score was analysed independently and summarized using either the mean and standard deviation (SD) for normally distributed data or the median with interquartile range (IQR) for skewed data.

Multiple logistic regression analysis was performed to identify factors that were independently associated with influenza vaccination uptake among primary HCWs. Both Backward Likelihood Ratio and Forward Likelihood Ratio methods were initially applied during the model-building process to assess the best-fitting model. The variables that showed a p-value of less than 0.25 in the univariate analysis were included in the multivariate logistic regression analysis. After comparison, the Forward Likelihood Ratio method was chosen for the final model, as it retained the most statistically significant variables while achieving a better model fit. The results of the logistic regression analysis were presented as crude odds ratios (OR) and adjusted odds ratios (Adj. OR) with their corresponding 95% confidence intervals (CI). To assess model assumptions, multicollinearity was examined using Variance Inflation Factor (VIF). A VIF of less than 10 and tolerance above 0.1 were considered acceptable. The model's goodness-of-fit was evaluated using the Hosmer-Lemeshow test, and the Nagelkerke R^2 was reported to indicate the model's explanatory power. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Characteristic of Participants

The study involved participants aged 22 to 57 years, (mean=37.9 years, SD=7.09). Three-quarters of the participants were female, and nurses constituted the largest occupational group (33.7%). The duration of service ranged from 1 to 34 years, with a mean of 13.0 years (SD = 7.31), and 90.8% reported direct patient exposure (Table 1). A small percentage reported pre-existing medical illnesses, including asthma (3.6%) and heart disease (1.6%).

Influenza Vaccination Uptake

The majority of participants (97%) reported previous influenza vaccination, with only 12 HCWs in Seberang Perai Tengah reporting no prior vaccination (Table I). This small number of unvaccinated participants (n=12) may limit the model's discriminatory power and stability, and a low event rate could affect generalizability and precision of estimates.

Among the 347 vaccinated participants, the most frequently reported reasons were self-protection (94.2%), protecting family and friends (70.9%) and the availability of free vaccination at the workplace (50.7%) (Figure 1). For the 12 unvaccinated HCWs, the most common reason cited was concern about side effects (58.3%), followed by fear of getting sick from the vaccine and personal reluctance (each 25%) (Figure 2).

Knowledge and Attitude Towards Influenza and Its Vaccination

Table II presents the responses of HCWs to 18 knowledge and attitude statements. Most participants (over 60%) agreed that influenza is a serious health threat, and that vaccination is safe and worthwhile. However, misconceptions persisted, particularly regarding transmission routes (item 12), with 39.3% incorrectly believing influenza is blood or bodily fluid-borne, and vaccine side effects (item 17), where 30.4% believed the vaccine could cause infection. Additionally, 27.6% mistakenly believed they were not at increased risk (item 14), despite their direct patient contact.

The knowledge scores of participants ranged from 0 to 15, with a median score of 11.0 (IQR 4.0). Two participants achieved the maximum score of 15. In contrast, 20 participants had a knowledge score of zero. The median knowledge score for vaccinated participants was 11.0 (IQR 4.00) while for not vaccinated participants the mean score was 6.2 (SD 3.46). The score distribution for vaccinated participants was slightly skewed to the left (skewness=-1.135), indicating a concentration of higher scores. In contrast, the non-vaccinated group's distribution was approximately symmetrical (skewness=0.037). A Mann-Whitney test indicated a significant difference in knowledge scores between the two groups (Z=-3.142, p=0.002).

Attitude scores ranged from 0 to 3, with an overall mean score of 2.1 (SD 1.12). Majority of participants (n=191) achieved the maximum score of 3, while 60 participants scored zero. These participants with zero marks for attitude most often selected "Neutral" for their answers. The median score for vaccinated participants was 3.0 (IQR 1.00), while the means score for not vaccinated participants was 1.1 (SD 1.31). The score distribution for vaccinated participants was left-skewed (skewness=-1.049), while the not vaccinated group's distribution was slightly right-skewed (skewness=0.690). The Mann-Whitney test showed that vaccinated participants had a significantly higher attitude score than the not vaccinated participants (Z=-2.834, p=0.005).

Factors Associated with Influenza Vaccination Uptake

Prior to interpreting regression findings, model assumptions were assessed. Multicollinearity was not a serious issue, with all included variables having VIF values below 6.1 and tolerance values above 0.16. The Hosmer-Lemeshow test indicated good model fit (χ^2 = 4.321, df = 7, p=0.742). The overall model was statistically significant (p<0.05) and explained 14.8% of the variance in vaccination uptake (Nagelkerke R^2 = 0.148).

Multiple logistic regression analysis revealed that total attitude score was a significant predictor of influenza vaccination uptake (p=0.002). Each one-point increase in a participant's attitude score was associated with a more than two-fold increase in the odds of vaccinated (Adj. OR: 2.12; 95% CI: 1.30–3.44). The total knowledge score was not a significant predictor in the final model (p=0.645).

Subgroup analysis for Knowledge and Attitude Scores

Knowledge and attitude scores varied significantly by occupation. Doctors had the highest median knowledge score (13.00, IQR 2.00), closely followed by pharmacists (mean = 11.33, SD = 2.23). Conversely, nurses exhibited the lowest mean knowledge score (8.64, SD 4.30). For attitudes, pharmacist had the highest mean score (2.75 SD 0.62), and nurses again had the lowest mean score (1.99 SD 1.25). Further subgroup analysis of participants with low knowledge scores (defined as ≤10) and low attitude scores (defined as ≤2). Of the 164 low-knowledge scoring participants, the highest proportion of participants with poor knowledge were assistants or aides (54.0%, n=47), followed by nurses (52.9%, n=64) and medical assistants (51.3%, n=20). In contrast, doctors had the lowest proportion of poor knowledge (14.3%, n=6). Of the 168 low-attitude scoring participants, the highest proportion of participants with a poor attitude were technicians (66.7%, n=4), followed by allied health professionals (57.1%, n = 8), and dentist (52.6%, n=20). Pharmacists had the lowest proportion of poor attitude (16.7%, n=2).

A Spearman correlation analysis showed no significant correlation between years of service and either knowledge scores (r=-0.018, p=0.740) or attitude scores (r=0.016, p=0.756). Consistent proportions of low-scoring participants were observed across all years of service categories. For this analysis, year of service was categorized into five groups: 0-5 years, 6-10 years, 11-15 years, 16-20 years, and more than 20 years. For knowledge scores, the percentage of participants with poor knowledge ranged from 41.8% to 49.3%. Similarly, for attitude scores, the percentage of participants with a poor attitude ranged from 43.3% to 48.9%, showing no strong differentiation across year of service categories.

Table I: Sociodemographic characteristics and influenza vaccination uptake (n=359)

Characteristics	Numbers (n)	Percentage (%)
Age(year)		
Mean (SD)	37.9	7.09
Gender		
Male	80	22.3
Female	279	77.7
Ethnic		
Malay	273	76
Chinese	42	11.7
Indian	34	9.5
Others	10	2.8
Education Level		
Primary education	3	0.8
Secondary education	89	24.8
Diploma	155	43.2
Bachelor's degree	90	25.1
Master's degree	12	3.3
Professional degree	10	2.8
Job categories		
Doctor	42	11.7
Dentist	38	10.6
Medical Assistant	39	10.9
Nurse	121	33.7
Allied Health Professional	14	3.9
Pharmacist	12	3.3
Technician	6	1.7
Assistant or aide	87	24.2
Years of service (years)		
Mean (SD)	13.0	7.31
Exposure to patients	326	90.8
Medical Illness	61	17.0
Asthma	13	3.6
Endocrine	17	4.5
Heart Disease	6	1.6
Kidney Disease	1	0.3
Others	29	7.7
Vaccination uptake:		
Ever vaccinated	347	97
Never vaccinated	12	3

DISCUSSION

Vaccination uptake rates

This study revealed an exceptionally high influenza vaccination uptake rate of 97% among HCWs in Malaysian public primary care settings. This remarkable figure highlights the successful implementation of influenza vaccination initiatives within this healthcare district. The high coverage rate can be attributed to institutional strategies, including the provision of free and accessible vaccination services, and favourable attitude among HCWs. Notably, the observed coverage exceeded the World Health Organization's target of 75% vaccination among HCWs.[22] A recent report from Occupational and Environmental Health Unit reported 85% of the HCWs in the district agreed for the vaccination in 2024 (unpublished data). The vaccination process in the district was still ongoing during the data collection period and the latest registration for the health district showed (76.9%) of HCW had been vaccinated (unpublished data).

These findings are in stark contrast to previous local studies, which reported a lower uptake ranging from 7.2%-67.2%.[9, 11-13] Internationally, similar challenges are evident. Studies from India and Turkey have reported low-4.4% to 9.2% uptake rates.[23,24] The decision to vaccinate is often influenced by a perceived risk of disease severity and concerns over vaccine-related side effects.[25] Sun et al reported that the COVID-19 pandemic led to a sustained increase in influenza vaccination rate, driven by heightened public awareness of disease prevention and control, as well as changes in health-related behaviours, thus enhanced willingness to receive vaccination.[26] This post-COVID pandemic impact could partly contributed to the high vaccination uptake in our study.

Studies have reported a high acceptance rate in Mexico, United States and Singapore. In Mexico, a survey found an 80% acceptance rate among HCWs in three urban hospitals, with key motivators being the perceived safety and the efficacy of the vaccine.[27] Similarly, in the United States, 78.6% of participants reported receiving an influenza vaccine during the 2016-2017 season,[28] bolstered by mandatory vaccination policies in some states. Singapore, a neighbouring country, has also achieved a high vaccination rate of 82% among HCWs.[29] Like Malaysia, influenza vaccination in Singapore is free and encouraged by the

Table II: Knowledge and attitude towards influenza vaccination among HCWs (n=359)

No	About Influenza Vaccination	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)	Strongly disagree N (%)
1	I am at risk of getting flu	142 (39.6)	80 (22.3)	85 (23.7)	29 (8.1)	23 (6.4)
2	People around me are at risk of getting flu	154 (42.9)	80 (22.3)	86 (24.0)	21 (5.8)	18 (5.0)
3	Flu is a serious threat to my health	120 (33.4)	103 (28.7)	101 (28.1)	22 (6.1)	13 (3.6)
4	Flu is a serious threat to the health of people around me	124 (34.5)	105 (29.2)	99 (27.6)	16 (4.5)	15 (4.2)
5	Flu vaccination can protect me from getting the flu	139 (38.7)	127 (35.4)	62 (17.3)	16 (4.5)	15 (4.2)
6	If I get a flu vaccination, people around me will be better protected from flu	142 (39.6)	112 (31.2)	79 (22.0)	13 (3.6)	13 (3.6)
7	Flu vaccination is safe	160 (44.6)	116 (32.3)	57 (15.9)	14 (3.9)	12 (3.3)
8	Getting vaccinated for flu is worth the time and expense	150 (41.8)	120 (33.4)	64 (17.8)	11 (3.1)	14 (3.9)
9	Health care workers should be rewarded for getting vaccinated for flu	149 (41.5)	89 (24.8)	75 (20.9)	21 (5.8)	25 (7.0)
10	Health care workers should be required to be vaccinated for flu	167 (46.5)	90 (25.1)	72 (20.1)	12 (3.3)	18 (5.0)
11	Influenza is more serious than a bad cold	192 (53.5)	94 (26.2)	53 (14.8)	7 (1.9)	13 (3.6)
12	Influenza virus is transmitted by contact with blood and body fluids	75 (20.9)	66 (18.4)	66 (18.4)	55 (15.3)	97 (27.0)
13	Influenza virus is transmitted by coughing and sneezing	211 (58.8)	89 (24.8)	33 (9.2)	11 (3.1)	15 (4.2)
14	Healthcare workers are less susceptible to influenza infections than other people	39 (10.9)	60 (16.7)	64 (17.8)	65 (18.1)	131 (36.5)
15	The signs and symptoms of influenza include fever, headache, sore throat, cough, nasal congestion, and aches and pains	229 (63.8)	77 (21.4)	31 (8.6)	6 (1.7)	16 (4.5)
16	People with influenza can transmit the virus before they experience symptoms	146 (40.7)	118 (32.9)	66 (18.4)	17 (4.7)	12 (3.3)
17	The influenza vaccination may cause some people to get influenza	55 (15.3)	54 (15.0)	121 (33.7)	58 (16.2)	71 (19.8)
18	You can get vaccinated for influenza without an injection	26 (7.2)	35 (9.7)	85 (23.7)	76 (21.2)	137 (38.2)

Table III: Simple and multiple logistic regression analysis of factors associated with influenza vaccination uptake (n=359)

Variable	Not vaccinated n=12		Vaccinated n=347		Simple Logistic Regression		Multiple Logistic Regression	
	Mean (SD)	n (%)	Mean (SD)	n (SD)	Crude OR (95% CI)	p-value	Adj OR (95% CI)	p-value
Age(year)	32.0 (9.25)[a]		38.0 (7.08)		1.09 (0.99, 1.20)	0.079		
Gender						0.636		
Male		2 (2.5)		78 (97.5)	1.00 (ref.)			
Female		10 (3.6)		269 (96.4)	1.45 (0.31, 6.76)			
Ethnic								
Malay		11 (4.0)		262 (96.0)	-			
non-Malay		1 (1.2)		85 (98.8)	-			
Education Level						0.205		
Secondary and below		5 (5.4)		87 (94.6)	1.00 (ref)			
Tertiary		7 (2.6)		260 (97.4)	2.14 (0.66, 6.90)			
Job categories								
Professional		1 (1.1)		91 (98.9)	-			
Paramedics		7 (3.8)		175 (96.2)	-			
Non-clinical		4 (4.7)		81 (95.3)	-			
Years of service (years)	7.0 (10.50)[a]		13.2 (7.30)		1.10 (1.00, 1.21)	0.063	1.10 (1.00, 1.22)	0.053
Exposure to patients						0.372		
Yes		10 (3.1)		316 (96.9)	0.49 (0.10, 2.34)			
No		2 (6.1)		31 (93.9)	1.00 (ref)			
Medical Illness						0.976		
Yes		2 (3.3)		59 (96.7)	0.98 (0.21, 4.57)			
No		10 (3.4)		288 (96.6)	1.00 (ref)			
Knowledge score	6.2 (3.46)		11.0 (4.00)[a]		1.19 (1.05, 1.35)	0.006		
Attitude score	1.1 (1.31)		3.0 (1.00)[a]		2.06 (1.28, 3.30)	0.003	2.12 (1.30, 3.44)	0.002

Note: Multiple Logistic Regression analysis using the Forward method
Nagelkerke R square 14.8%
SD = Standard Deviation; OR = Odds Ratio; Adj. OR= Adjusted Odds Ratio; 95% CI = 95% Confidence Interval
[a] Median (Interquartile range, IQR)

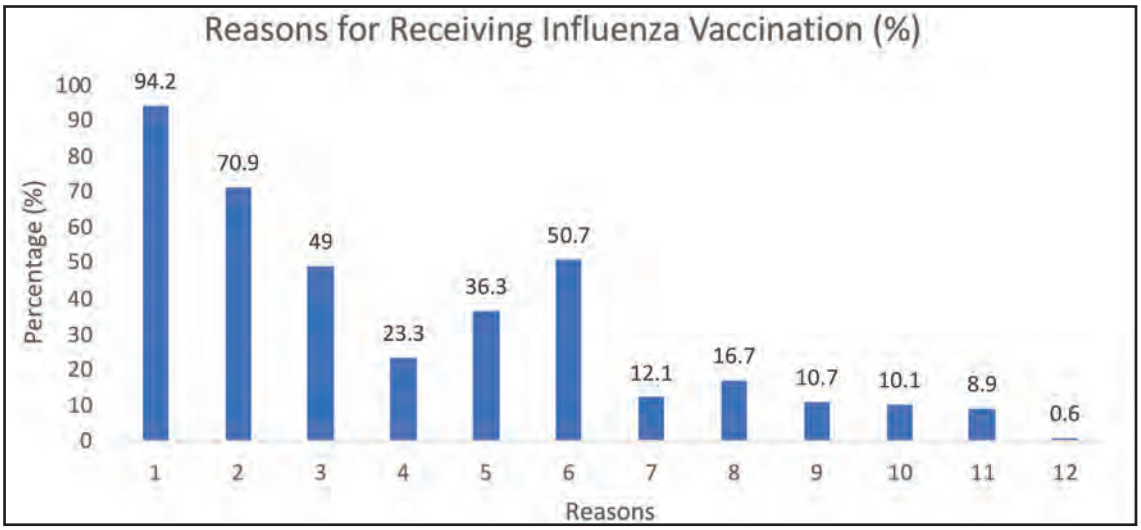

Fig. 1: Percentage of the reasons for receiving influenza vaccination among vaccinated HCWs (n = 347) 1. To protect myself from flu, 2. To protect my friends or family from flu, 3. To protect patients from getting flu, 4 Avoid missing work, 5. It is easy to get flu vaccination at work, 6. Flu vaccine was offered free of charge at work, 7. My employer pays for the time used to get a flu vaccination, 8. My employer recommends that I get a flu vaccination, 9. My employer requires me to be vaccinated for flu, 10. A physician or nurse recommended flu vaccination to me, 11. My colleagues at work recommended flu vaccination to me, 12. To travel

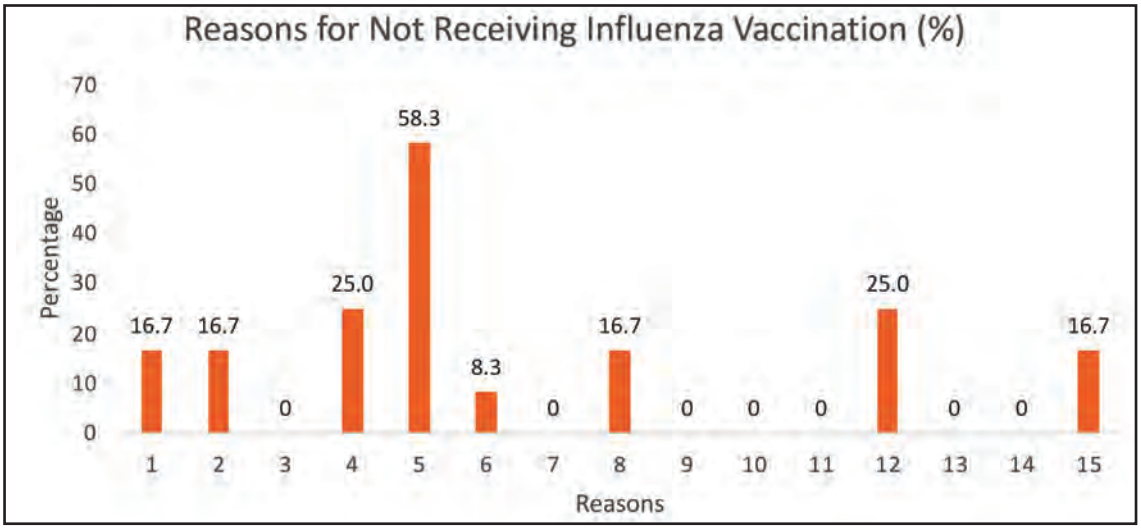

Fig. 2: Percentage of reasons for not receiving influenza vaccination among non-vaccinated HCWs (n= 12) 1. I don't need it, 2. Others need to be vaccinated more than I do, 3. I already had the flu, 4. I might get sick from the vaccine, 5. I may experience side effects, 6. I am allergic to the vaccine, 7. I dislike needles, 8. I haven't gotten around to it / I don't have the time, 9. I don't think that flu vaccines work, 10. There was no vaccine available, 11. Flu vaccines cost too much, 12. I just don't want the vaccine, 13. My employer didn't require me to have a vaccination, 14. My medical care provider recommended that I not get the vaccine, 15. Pregnant

health authorities. Key motivators included higher educational level, belief in the influenza severity, and vaccine safety. Barriers such as fear of adverse effects and doubts about vaccine efficacy were also noted, findings that mirror our local data.[29]

Reasons for vaccination

Among vaccinated participants, the primary motivations included self-protection (94.2%), protecting family and friends (70.9%), and access to free workplace vaccination (50.7%). This reflects Malaysia's collectivist culture, in which family-oriented values strongly influence health decisions. Kegl et al reported similar motivators in a study in Slovenia, such as self-protection and the protection of family and patients.[30] Likewise, Hollmeyer et al emphasised the importance of self-protection and convenience as key determinants of vaccine acceptance.[31] The availability of free and easily accessible vaccination services, such as mobile carts or on-site options, has been shown to significantly enhance vaccination rates,[32] and likely played a major role in the high uptake observed in this study.

Reasons for non-vaccination

Among the small proportion of unvaccinated HCWs, the most cited reason for non-vaccination was concern about side effects (58.3%), followed by fear of illness caused by the vaccine and general reluctance (25% each). These reasons are consistent with reports from Qatar and China, where concerns over vaccine safety remain significant barriers, even among medical professionals.[33,34] For example, Kegl et al reported that HCWs declined vaccination due to personal health beliefs and concerns about potential adverse effects of the vaccine.[30] This suggests that medical training alone does not guarantee vaccine literacy or confidence.

In our study, 16.7% of unvaccinated participants cited pregnancy as a reason for declining the vaccine. Inactivated vaccines are generally safe. Vila-Candel et al reported that the vaccine rejection among pregnant women was attributed to a lack of knowledge and insufficient information regarding influenza vaccination.[35] The WHO strongly recommends influenza vaccination during pregnancy to reduce maternal and neonatal complications.[1] Similarly, the Centers for Disease Control and Prevention (CDC) confirms the safety and importance of vaccination during any trimester, as pregnancy increases the risk of severe influenza outcomes.[36] The fact that such misconceptions exist among HCWs who are expected to educate and counsel patients, raises concerns about the potential downstream impact on community health behaviours.

Knowledge and attitude scores and misconceptions

A crucial finding of this study is the distinction between the roles of knowledge and attitude in influencing vaccination behaviour. While both knowledge and attitude scores were significantly higher among vaccinated participants in initial comparisons, only the attitude score emerged as a statistically significant predictor in the multivariate analysis. This suggests that while factual knowledge is important, it may not be the primary driver for vaccination in this cohort. The decision to get vaccinated appears more strongly influenced by underlying beliefs, trust in vaccine safety, and the perceived value of vaccination. This is consistent with literature supporting the Health Belief Model, where perceived susceptibility, severity, benefits, and barriers are strong determinants of preventive health behaviour.[37]

Knowledge of vaccines, including their efficacy and safety, plays a critical role in strengthening HCWs confidence in communicating the risks and benefits of vaccination. HCWs who trust the safety and efficacy of influenza vaccination were more likely to recommend it to their patients.[32] However, their capacity and confidence can be undermined when they are not adequately equipped with the necessary information to address patients' questions or engage in informed discussions about vaccination.

Targeted educational intervention should be developed to address specific misconceptions and promote evidence- based understanding of vaccine benefits and safety. Educational interventions could be tailored to the primary care setting, such as workplace seminars and e-learning modules with quiz-based reinforcement. Targeted informational posters or infographics is crucial for addressing key misconceptions about influenza vaccination: emphasizing its inactivated nature to dispel fears of causing flu (a misconception held by 30.3% of participants), clarifying that influenza is not transmitted through blood (incorrectly believed by 39.3% of respondents), and reinforcing its safety profile while debunking concerns about side effects. Misconceptions concerning transmission mode and influenza vaccination may drive lower scores. Integrating digital technologies such as vaccine tracking systems and automated reminder platforms can also streamline processes and improve adherence.

Local studies found that increasing age was significantly associated with influenza vaccination uptake, but not other socio-demographic characteristics.[12,13] However, our study did not identify statistically significant associations with socio-demographic characteristics, similar to another local study.[9]

LIMITATIONS

Despite 36.6% of response rate, the participants were from all 15 clinics in the health district and from various health professions. We acknowledge that recruitment via WhatsApp groups and voluntary participation may introduce a degree of self-selection bias. HCWs who are more engaged, tech-savvy, or have a greater interest in influenza vaccination may have been more inclined to participate. However, this approach was chosen for its practicality in reaching a dispersed population across multiple clinics.

Social desirability bias may have influenced participants' self-reported vaccination status, potentially leading them to report higher vaccination rates than actual. The reliance on self-reported data without verification against official immunisation records may introduce recall bias. The voluntary nature of participation and the non-respondents – those who declined participation or did not provide consent may differ systematically from respondents, which could limit the generalizability of the findings. Vaccine hesitancy can be fueled by misinformation within healthcare settings and may have impacted participants' responses. This study is limited by its cross-sectional design which precludes causal inference. Weak explanatory model (Nagelkerke R^2 = 14.8%), suggested that other unmeasured factors may also influence vaccination uptake. Longitudinal studies would be invaluable to track vaccination behaviour over time. Intervention assessment studies are also warranted to evaluate the effectiveness of targeted educational programs designed to address specific misconceptions and enhance vaccine confidence. Furthermore, cross-regional comparisons of influenza vaccination uptake rates and associated factors within Malaysia and across Southeast Asia could provide broader insights into the effectiveness of different institutional strategies.

CONCLUSION

This study provides an assessment of influenza vaccination uptake among HCWs in Seberang Perai Tengah, Penang, revealing a remarkably high coverage rate of 97%. The findings highlight the critical role of institutional strategies, particularly the provision of free and easily accessible

workplace vaccination in facilitating vaccine uptake. These system-level facilitators, coupled with generally positive health beliefs among HCWs, were associated with the high compliance observed. Despite this, a small proportion of HCWs remain hesitant, with concerns mainly related to vaccine safety and potential side effects, underscoring the persistent influence of misinformation and vaccine mistrust, even within healthcare settings. This study offers valuable insights into influenza vaccination among HCWs. Continued investment in staff education, vaccine availability, and supportive policies may further consolidate these gains while protecting both HCWs and the communities they serve.

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