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Factors Associated with Influenza Vaccination Uptake Among Healthcare Worker in Tertiary Hospitals in Perak, Malaysia

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Influenza is the leading cause of respiratory illness worldwide. Healthcare workers (HCWs) are at high risk of infection and can easily spread the disease. Influenza vaccination is an important preventive action to stop the transmission of this disease. However, the uptake among HCWs remains low. Therefore, this study aims to measure the prevalence of influenza vaccination and to determine the factors associated with influenza vaccination uptake among HCWs in tertiary hospitals in Perak, Malaysia. A cross-sectional study was carried out in two specialist hospitals in Perak. It involved 775 nurses and assistant medical officers who were selected using simple random sampling. The study used a self-administered questionnaire that contained a section on sociodemographic characteristics, the knowledge, behavior and health literacy questionnaire and a section on the uptake of the influenza vaccination of 2016/2017. The prevalence of influenza vaccination uptake was 25.5%. A multivariate logistic regression showed that the factors associated with influenza vaccination were increasing age (OR 1.04; 95% CI 1.01,1.08); working in an emergency department (OR 7.20; 95% CI 1.45,35.69) or obstetrics & gynaecology department (OR 0.17; 95% CI 0.04,0.85) compared to other departments; working as a community nurse compared to an assistant medical officer (OR 8.48; 95% CI 1.33,54.0); and higher influenza knowledge (OR 1.19; 95% CI 0.99,1.42). In conclusion, influenza vaccination coverage was found to be low. The above-identified factors inform future vaccination campaigns and the development of targeted intervention programmes to increase influenza vaccination uptake.

Keywords: influenza; healthcare worker; prevalence; vaccination

I. INTRODUCTION

Influenza is the leading cause of respiratory illness worldwide. It is caused by ribonucleic acid viruses from genera of the Orthomyxoviridae family [1]. There are four types of influenza virus: A, B, C and D [2]. It causes a spectrum of respiratory tract infections ranging from mild upper respiratory tract infection to severe pneumonia [3]. The World Health Organization (WHO) has estimated that influenza is responsible for about three to five million cases of severe illness and 290,000 to 645,000 respiratory deaths annually [2].The term 'healthcare worker' is an umbrella term that covers a variety of job categories such as, for example, doctors, nurses, assistant medical officers, and allied health and support service workers. They are at high risk of infection and can easily spread the disease due to the work nature [4]. Hence, the influenza vaccination is an important preventive action that can be taken in order to stop the

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transmission of this disease [1]. Globally, the uptake of influenza vaccine among HCWs varies from 4.4% to 83% [5–17] . A Malaysian study by Hudu et al. (2016) using self-reported questionnaire reported a 51% uptake of influenza vaccination [18] which is much lower than the targeted 90% coverage for HCWs set by the Healthy People 2020 objective in the USA [19]. Thus, the factors associated with the uptake of the influenza vaccination among HCWs need to be studied in order to understand the reasons behind the poor uptake in Malaysia. This study aims to measure the prevalence of influenza vaccination and to determine the factors. Identifying the associated factors will provide window of opportunity in planning targeted interventional program to increase the coverage, thereby improve the HCW and patient's health, wellbeing and cost saving.

A. The Theoretical Model

The conceptual framework for this study has been adapted from the Health Belief Model to assess vaccination behaviour among HCWs [20] (Figure 1). Corace et al. (2016) in their systematic review conclude that HBM found to be the most frequently employed theory to predict the factors associated with influenza vaccination uptake among HCWs [21].There are five constructs in the original version of the HBM: perceived susceptibility, perceived severity, perceived benefits, perceived barriers and cues to action [20]. More recent studies have added health motivators, attitude and self-efficacy to the model [7,14]. Adding to the above, we also included the component of health literacy in the construct to explain the likelihood of having an influenza vaccination. We use the definition of health literacy by Nutbeam which refers to three level of health literacy include functional, communicative and critical health [22]. Functional HL reflects the extent to which people had experience difficulty in reading or writing in order to function in daily task. Communicative HL reflect the extent to which people had extracted and communicated information and apply the new information to different situations. Critical HL reflects to the extent to which people had critically analysed the information and used it to make decisions.

II. MATERIALS AND METHOD

A. Study Population and Study Sampling

A cross-sectional study was carried out in two specialist hospitals in Perak. We randomly select two out of the 15 public hospitals in Perak: Hospital Raja Permaisuri Bainun (HRPB) and Hospital Taiping. A list of nurses and assistant medical officers was obtained from the human resources department of each hospital. Participants were randomly selected from these lists using STATA version 14.0. We included nurses and assistant medical officers who had been working in HRPB and Hospital Taiping for a minimum period of 12 months and excluded other categories of staff and those who refused to participate. To calculate the sample size, we used study by Scott et al as a reference with odds ratio of 1.7 and ratio of unexposed to exposed group of 0.45 [23]. With confidence interval set at 95%, a power of 80% and a non-response rate of 30%, using Open Epi software we estimated that 909 participants would be required. An attempt to recruit more participants was made by distributing 1100 questionnaires in total.

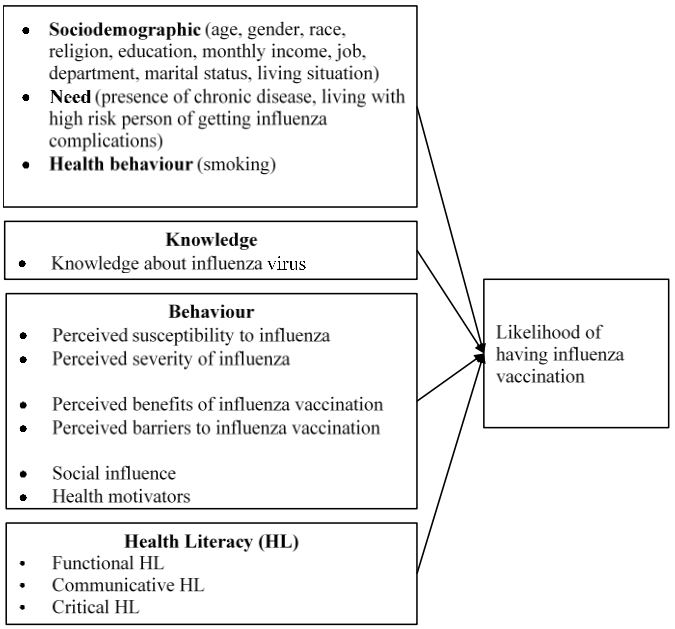

Figure 1. Conceptual framework adapted from the health belief model

B. Measures

The study used a self-administered questionnaire that contained a section on sociodemographic characteristics, the knowledge (KQ), behaviour determinants (BDQ) and health literacy questionnaire (HLQ) and a section on the uptake of the influenza vaccination of 2016/2017 season. The original questionnaires were translated into the national language of Malaysia (Bahasa Melayu) and subjected to a validation process include content validation, face validation and reliability testing among 100 HCWs in tertiary hospital in Selangor.

1. Demographic characteristics

The following sociodemographic information was collected from the participants: age, gender, race, religion, education level, job category, department, monthly income, chronic disease, marital status, smoking status, and living with person at high risk of getting influenza complications.

2. Knowledge questionnaire

The knowledge questionnaire was based on the questionnaire developed by Tahir Mehmood Khan et al [24]. After the validation process, only eight of the original 11 items were retained. The calculation of reliability using the Kuder-Richarson 20 formula for the 8-item produced a value of 0.5768, which was considered acceptable [25]. The intra-class coefficient correlation (ICC) for all the items ranged from 0.51 to 0.84, which indicated moderate to good reliability [26]. The participants respond to the items in the questionnaire by selecting a multiple-choice answer of either 'true', 'false' or 'not sure'. The correct answer was given 1 point, whereas incorrect and not sure answers were given 0 points. The points for the answers were summed to give a minimum score of zero and a maximum score of eight.

3. Behavioural determinants questionnaire

The behavioural determinants of influenza vaccination uptake were assessed by using an adapted version of a questionnaire originally developed by Asma et al [7]. The original questionnaire contained 46 items. However, as a result of the validation process, six items were discarded due to their poor correlation. Overall, the Cronbach's alpha for the 40 items BDQ was 0.7880, which indicated good internal consistency [26]. The ICC ranged from 0.75 to 0.93, which indicated good to excellent reliability [26]. The remaining 40 items fell under the eight constructs of perceived susceptibility (four items), perceived severity (three items), perceived benefits (four items), perceived barriers (ten items), motivating factors (five items), social influence (five items), attitude (four items) and self-efficacy (five items). The answers given by the respondents were expressed as 1 = 'strongly disagree', 2 = 'disagree', 3 = 'neutral', 4 = 'agree', and 5 = 'strongly agree'. Strongly agree and agree was given 1 point, whereas neutral, disagree and strongly disagree were given 0 points. The scores for the items were summed to give a total score for each domain. The average score of each domain was then calculated, where a higher score represented a greater agreement with the respective construct.

4. Health literacy questionnaire

The questionnaire that was used to measure HL was based the one developed by Ishikawa et al [27] and was adapted to reflect the topic of influenza vaccination. It consists of 14 items covering three dimensions of HL: functional (five items), communicative (five items) and critical (items). The questionnaire was validated, giving a Cronbach's alpha of 0.79, 0.92, and 0.93 for functional, communicative and critical HL, respectively which indicated good internal consistency. Moreover, the ICC for functional, communicative and critical HL ranged from 0.60 to 0.89, which indicated moderate to good reliability [26]. The answers given by the respondents was assessed on a four-point Likert scale ranging from 1 = 'never' to 4 = 'often'. The scores for the items were summed and divided by the number of items in the domain to give a total score (theoretical range 1–4) [27]. The scores were reversed for functional HL such that a higher score indicated a higher HL.

5. *Influenza vaccination uptake*

Regarding influenza vaccination, participants were asked, "Did you have an influenza vaccination between 1 November 2016 and 31 October 2017?" The answer they gave was verified against the data in the vaccination record held by the in Public Health Unit of the studied hospitals.

C. Statistical Analysis

The prevalence of influenza vaccination uptake was reported as a percentage. Comparisons between the vaccination uptake and the non-vaccination uptake groups was performed by using the chi-square test for categorical data and the t-test for numerical data. Nonparametric Fisher exact test or Mann–Whitney U when data was not normally distributed. To identify the variables explaining the vaccination uptake, the independent variables were modelled against the vaccination status by using multiple logistic regression. Two models were tested based on the conceptual framework. In model 1 (base model), the sociodemographic characteristics were investigated as factors for vaccination uptake. In model 2, knowledge, behavioural determinants and HL were added to create the fully adjusted model where it adjusted all the variables available. The statistical significance of the models was set at $p < 0.05$ and this was maintained in the final model. All analyses were performed using STATA version 14.0 (serial number 301406227318).

1. *Ethics*

Ethics approval for this study was granted by the Medical Research & Ethics Committee (NMRR-17-333-34417(IIR)) of the Malaysian Ministry of Health. Written inform consent was obtained from the participants.

III. RESULT

According to the staff numbers at each hospital, 700 questionnaires were distributed to HRPB and 400 to Hospital Taiping. A total of 800 participants consented to participate: 412 from HRPB (response rate = 58.9%) and 388 from Hospital Taiping (response rate = 97%). Out of the 800 who returned the questionnaires, 25 (3.1%) were excluded where 20 (2.5%) with incomplete data and five (0.6%) were duplicates. Therefore, 775 with completed data were subjected to analysis.

A. Sociodemographic Characteristics of The Study Population

The mean age of the participants was 34.9 (±7.69) years. The majority were female (91.9%), Malay (87.7%), Muslim (88.0%) and had a tertiary education (87.5%). Most of the participants also had a middle income; 52% reported a monthly income of Malaysian ringgit (RM) 3001–RM5000. The participants held the following positions: sisters (8.8%), registered nurses (74.1%), community nurses (11.6%) and assistant medical officers (5.6%). With regards to department, 31.0% were from a medical department, 13.0% from surgical, 21.0% from obstetrics and gynaecology (O&G), 6.7% from anaesthesiology, 10.1% from orthopaedics, 5.2% from trauma and emergency and 2.8% from other departments. Only a few of the participants stated that they had one or more chronic disease (108, 14.0%). With regards to smoking, 97.2% had never smoked, 2.4% had previously smoked and 0.4% were currently smoking. The participants were either married (79.7%), separated (0.3%), divorced (2.5%), widowed (0.5%) or single (17.0%).

Based on the immunization records, the prevalence of influenza vaccination among HCWs was 25.5%.

B. Comparison Between Vaccinated and Non-Vaccinated HCWs

Table 1 shows the comparison between vaccinated and non-vaccinated HCWs. It can be seen that the mean score for knowledge and each of the types of HL was higher among the vaccinated than among the non-vaccinated group. Notably, the median was in the higher range for all behavioural domains except for the perceived barriers domain among both groups. The result showed that there was an association between vaccination uptake and department ($p < 0.001$), total knowledge score ($p= 0.004$) and critical health literacy ($p=0.0499$).

Table 1. Comparison between Vaccinated and Non-Vaccinated HCWs

Variable	Non-vaccinated N = 577 n (%)	Vaccinated N = 198 n(%)	P value
Age (Mean ± SD)	34.71 (± 7.63)	35.24 (± 7.86)	0.425
Gender			
Male	48 (8.3)	15 (7.6)	0.741
Female	529(91.7)	183(92.4)	
Education			
Secondary school	76 (13.2)	21 (10.6)	0.347
Tertiary	501 (86.8)	177 (89.4)	
Job category			
Assistant medical officer	33 (5.7)	10 (5.0)	0.935
Sister	52 (9.0)	16 (8.1)	
Community nurse	68 (11.8)	22 (11.1)	
Registered Nurse	424 (74.5)	150 (75.8)	
Department			
Medical	165 (28.6)	75 (37.9)	**<0.001**
Surgical	75 (13.0)	26 (13.1)	
Obstetrics & Gynaecology	152 (26.3)	11(5.6)	
Anaesthesiology	32 (5.6)	20 (10.1)	
Paediatric	49 (8.5)	29 (14.6)	
Orthopaedic	64 (11.1)	15 (7.6)	
Emergency	21 (3.6)	19 (9.6)	
Others	19 (3.3)	3 (1.5)	
Monthly income			
<RM3000	243 (42.1)	82 (41.4)	0.384
RM3001–RM5000	303 (52.5)	100 (50.5)	
>RM5001	31 (5.4)	16 (8.1)	
Present of chronic disease			
Yes	79 (13.7)	29 (14.6)	0.738
No	498 (86.3)	169 (85.4)	
	Mean ± SD	**Mean ± SD**	
Total knowledge score	4.89 ± 1.12	5.15 ± 1.12	**0.004**
Health Literacy			
Functional HL*	3.06 ± 0.73	3.08 ± 0.74	0.711
Communicative HL	2.72 ± 0.69	2.80 ± 0.58	0.172
Critical HL	2.99 ± 0.72	3.09 ± 0.70	**0.049**
	Median (range)	**Median (range)**	
Perceived susceptibility[a]	3.0 (0–4)	3.5 (0–4)	0.285
Perceived severity[a]	3.0 (0–3)	3.0 (0–3)	0.152
Perceived benefits[a]	4.0 (0–4)	4.0 (0–4)	0.295
Perceived barriers[a]	1.0 (0–7)	1.0 (0–6)	0.577
Social influence[a]	5.0 (0–5)	5.0 (0–5)	0.165
Motivating factors[a]	4.0 (0–5)	4.0 (0–5)	0.949
Attitude[a]	4.0 (0–4)	4.0 (0–4)	0.362
Self–efficacy[a]	4.0 (0–5)	4.0 (0–5)	0.876

Data were not normally distributed, Mann–Whitney U test
*Reverse scored for ease of interpretation

C. Factors Associated with Influenza Vaccination Among HCWs

As illustrated in Table 2, the fully adjusted model depicted that with a 1-year increase in the age, an HCW had 1.04 times the odds of getting an influenza vaccination (aOR 1.04; 95% CI 1.01, .08; p = 0.015). The model also revealed that a community nurse was 8.48 times more likely to have an influenza vaccination compared to an assistant medical officer (aOR 8.48; 95% CI 1.33, 54.0; p = 0.024). In addition, it showed that an HCW working in an O&G department had 0.17 times the odds of getting an influenza vaccination compared to working in another departments group (aOR 0.17; 95% CI 0.04, 0.85; p = 0.003). It also showed that a

HCW working in an emergency department had 7.20 times the odds of having an influenza vaccination compared to working in the other departments group (aOR 7.20; 95% CI 1.45, 35.69; p = 0.016). Lastly, the model depicted that a 1-point increase in the knowledge score led to an HCW having 1.19 times the odds of getting an influenza vaccination (aOR 1.19; 95% CI 0.99, 1.42; p value 0.050).

Table 3 shows the final model of the factors associated with influenza vaccination uptake among HCWs. Based on the final model, it was observed that three variables were the factors for influenza vaccination among HCWs, namely, working in the O&G department, working in the emergency department and working as a community nurse.

In this study, three methods were used to evaluate the goodness of fit of the logistic regression model include 1) Hosmer and Lemeshow test, 2) classification table and 3) receiver operating characteristics (ROC) curve analysis [28]. The Hosmer and Lemeshow goodness of fit test was applied to the final model and gave a result of p = 0.7886, which indicated that the model was a good fit [28]. The model also correctly classified 74.45% of the respondents. According to Hosmer et al area under the ROC curve of more than 0.7 is considered acceptable discrimination [28]. However, the area under ROC curve for model in this study was 0.6417, which meant that the model was able to accurately discriminate only 64.17% of the cases. Nevertheless, two out of the three measures applied to assess the goodness of fit of the model showed that the assumptions for the fitted model were met. We can thus conclude that the final model is achieved.

Table 2. Multiple Logistic Regression on Factors Associated with Influenza Vaccination Uptake among Healthcare Workers

Variables	**Base model aOR (95% CI)**	**P value**	**Fully adjusted model aOR (95% CI)**	**P value**
Sociodemographic				
Age	1.04 (1.01, 1.07)	**0.025**	1.04 (1.01, 1.08)	**0.015**
Gender				
Male	1.0		1.0	
Female	1.48 (0.55, 4.00)	0.439	2.23 (0.70, 7.14)	0.176
Education				
Secondary school	1.0		1.0	
Tertiary	1.86 (0.62, 5.60)	0.273	2.09 (0.65, 6.70)	0.215
Job category				
Assistant medical officer	1.0		1.0	
Sister	1.16 (0.28, 4.83)	0.836	0.86 (0.18, 4.09)	0.851
Community Nurse	9.97(1.76, 56.60)	**0.009**	8.48 (1.33, 54.0)	**0.024**
Registered Nurse	2.50(0.70, 8.90)	0.159	1.88(0.47, 7.49)	0.373
Department				
Other departments	1.0		1.0	
Medical	2.70 (0.74, 9.90)	0.133	1.77 (0.42, 7.52)	0.437
Surgical	1.99 (0.52, 7.65)	0.317	1.35 (0.31, 5.97)	0.688
O&G	0.24(0.06, 1.03)	**0.054**	0.17 (0.04, 0.85)	**0.003**
Anaesthesiology	3.75 (0.93, 15.05)	0.063	2.51(0.54, 11.75)	0.241
Paediatric	2.33 (0.59, 9.25)	0.229	1.43 (0.31, 6.55)	0.640
Orthopaedic	1.22 (0.30, 4.89)	0.778	0.79 (1.71, 3.67)	0.766
Emergency	9.77 (2.24, 42.56)	**0.002**	7.20 (1.45, 35.69)	**0.016**
Monthly income				
RM2001–RM3000	1.0		1.0	
RM3001–RM5000	0.90(0.58, 1.38)	0.639	0.95 (0.59, 1.53)	0.836
>RM5000	1.45(0.59, 3.57)	0.414	1.36 (0.51, 3.63)	0.533
Chronic Disease				
No	1.0		1.0	
Yes	0.90 (0.52, 1.54)	0.698	0.89 (0.50, 1.60)	0.707
Knowledge	-	-	1.19 (0.99, 1.42)	0.050
Behavioural determinants	-	-		
Perceived susceptibility	-	-	1.12 (0.94, 1.35)	0.209

Variables	Base model aOR (95% CI)	P value	Fully adjusted model aOR (95% CI)	P value
Perceived severity	-	-	0.78 (0.58, 1.05)	0.102
Perceived Benefits	-		1.13(0.90, 1.40)	0.284
Perceived Barriers	-		0.97 (0.84, 1.12)	0.686
Social influence	-		0.83(0.65, 1.04)	0.111
Motivating factors	-		1.05 (0.85, 1.28)	0.648
Attitude	-		0.88 (0.67, 1.14)	0.356
Self-efficacy			0.99 (0.86, 1.13)	0.901
Health literacy				
Functional HL	-		1.04 (0.79, 1.37)	0.797
Communicative HL	-		0.98 (0.65, 1.45)	0.919
Critical HL	-		1.08 (0.76, 1.53)	0.681

aOR: Adjusted odds ratio; CI: Confidence interval
Base model: adjusted for sociodemographic variables include age, gender, race, religion, education level, job category, department, monthly income, chronic disease, marital status, smoking status, and living with person at high risk of getting influenza complications.
Fully adjusted model: adjusted for sociodemographic, knowledge, behavioural and health literacy variables

Table 3. Final model on Factors Associated with Influenza Vaccination Uptake

Variable	Regression coefficient (B)	SE	P value	Exp (B)	95% CI
O&G	-2.07	0.04	**<0.001**	0.12	0.06, 0.25
Emergency	0.83	0.76	**0.012**	2.30	1.20, 4.40
Community nurse	0.87	0.75	**0.005**	2.39	1.29, 4.42
_cons	-0.93	0.04	<0.001	0.39	0.33, 0.47

IV. DISCUSSION

The overall purpose of this study was to investigate prevalence and the range of factors (sociodemographic, knowledge, behaviour and HL) associated with influenza vaccination among HCWs. Our results revealed that the prevalence of influenza vaccination was 25.5%. This is much lower than the targeted 90% coverage for HCWs set by the Healthy People 2020 objective in the USA [19]. The prevalence was lower than Canada (87.4%) [29],USA (78.4%) [8], Singapore (69.5%) [17] and Saudi Arabia (55.9%) [14]. The prevalence was almost similar with Australia (22%) [5] and European countries (25.7%) [11]. It should be noted that a secure comparison between the results in the current study and that in the previous studies are difficult considering the differences in the methodology and vaccination policy across studies.

A previous Malaysian study that measured influenza vaccination uptake for the 2013/2014 season showed a higher prevalence of 51% (Hudu et al., 2016). However, the data in that study was collected via self-report, and it is recognized that the self-reported vaccination rate tends to slightly overestimated [30]. Therefore, the results of the two studies are not directly comparable. A study undertaken in Canada measured seasonal influenza vaccination uptake by using staff vaccination records which is similar approach that adopted by the current study, and reported an impressive 87.4% vaccination uptake for the 2009/2010 season [29]. However, in this case, it is very likely that the effectiveness of the ongoing vaccination campaign in the studied hospital contributed to the high vaccination coverage.

Another challenge encountered in estimating and comparing the prevalence of uptake across countries is the variation in the vaccination policies implemented in individual countries. For instance, in USA a high prevalence rate (78.4%) was reported for the 2017/2018 season [8]. However, the USA, like Canada, has a mandatory vaccination policy. Hence it is not particularly surprising that both of these countries have been found to have an excellent level of

vaccination coverage. However, such results are not comparable with those reported herein because in the case of Malaysia voluntary vaccination is practised. Nor are the current results comparable with those of studies conducted in countries where a policy for influenza vaccination for HCWs is non-existent, as exemplified by a study in India that reported a prevalence of just 4.4.% [6].

This study found that an increase in age increased the likelihood of having the influenza vaccination among HCWs. This finding is consistent with those reported in previous studies [13,31–33]. The association of uptake with age could be due to the older age groups being more concerned about their general health or having higher awareness about infectious diseases [32].

The results also revealed that there was a significant difference in uptake between the vaccinated and non-vaccinated groups according to the department in which the HCW was currently working. This too is consistent with previous findings [5,7]. This study showed that working in an emergency department increased the likelihood of getting a vaccination as compared to working in another departments group. This seemed to imply that HCWs in an emergency department had a better understanding of the influenza virus. Moreover, the emergency department is considered a high-risk area [7] and as the first responders they have a risk of both contracting and transmitting the disease [34,35].

We also found that HCWs working in an O&G department were less likely to get an influenza vaccination than HCWs in the other departments group. A study conducted among paediatric nurses in Canada found that vaccination coverage is lowest among nurses in the antepartum and postpartum units and the main reason for the poor coverage was due to low personal need [36]. Similarly, a study among HCWs in a children' and women's hospital found poor vaccination coverage in the O&G department and the main reason was lack of fear about influenza [37]. The perceived low need and lack of fear about influenza could be due to the HCWs in O&G department rarely being exposed to or having to manage influenza patients. This may have led to their low level of awareness about the susceptibility and severity of the disease.

From our analysis, we discovered that there was a significant association between community nurses and vaccination uptake. Previous studies have reported that holding a job as a nurse is in general associated with having an influenza vaccination [5,38]. In Malaysia, the national childhood immunization programme is delivered by community nurses at the district level. Thus, they are exposed to the importance and benefits of vaccination and apply this knowledge in deciding to avail themselves of the influenza vaccination.

This study also found HCWs with a higher knowledge score were more likely to be vaccinated. This finding is consistent with previous studies [13,16,39]. Nevertheless, it indicates that there is an opportunity for evaluating the delivery of current vaccination campaigns and for designing future targeted educational programmes to enhance knowledge and to correct any misconceptions.

A range of behavioural domains and three types of HL were investigated in this study, however we found non-significant association between behavioural domains and HL and influenza vaccination. This is too contrast from previous study that found perceived susceptibility, perceived severity, perceived benefits, perceived barriers, social influence, health motivators, attitude and self-efficacy were significantly associated with vaccination [7,14,29]. The non-significant result of the current study could be due to the homogeneity of the study participants consisted of nurses and assistant medical officers who were predominantly female, Malay and from the same educational and economic background. Thus, the way they think and the way in which they perceive some things may not differ that much. In contrast, the studies cited above considered all categories of HCW in general. Another plausible reason for the non-significant findings could be due to a lack of awareness about influenza disease among HCWs.

Unlike previous studies that focused only on functional HL, this study attempted to measure a broader dimension of HL that included not only functional but communicative and critical HL. To the best of our knowledge, no study to date has measured the association between the three types of HL and influenza vaccination among HCWs. The result of the current study did not show any significant association between functional HL and influenza vaccination uptake. This is in contrast with a study in India that used Indian child health promotion materials as the HL measuring tool, found that mothers with a middle or high level of functional HL are significantly more likely than mothers with a low level of

functional HL to complete child vaccinations [40]. However, it should be noted that the study among mothers in India may not be comparable to this study on HCWs in Malaysia. This is because the participants in this study consisted of nurses and assistant medical officers in tertiary hospitals who are unlikely to have basic functional HL problems. Furthermore, the usage of a different tool for the measurement of functional HL makes comparison difficult.

We also found no significant difference in communicative HL among vaccinated and non-vaccinated HCWs in relation to influenza vaccination uptake. The study by Ishikawa et al also showed no association between communicative HL and diabetic complications [27]. In contrast, the study by Aharon *et al.* showed that parents with higher communicative HL are more at risk of not vaccinating their children [41]. The comparison with previous study is difficult due to differences in target population and outcome measure. The non-significant association in this study could be explained by a lack of understanding of the information obtained on influenza vaccination. The data showed that 24.1% of the participants answered that they never or rarely understood the influenza vaccination information. This means that, in communicative HL, what really affects vaccination uptake is the capacity to understand. Hence, a future vaccination campaign should be followed by an evaluation programme to ensure that participants in a future vaccination campaign comprehend the content of the programme and that the desired results have been achieved.

With regards to critical health literacy, the crude analysis showed that there was a significant association between critical HL and vaccination uptake among vaccinated and non-vaccinated HCWs, although the association was not significant in the multivariate analysis. Previous studies have reported multiple directions in the relationship between critical HL and preventive action or health outcome. For instance, Ishikawa et al reported that critical HL has a positive association with health outcome related to diabetes knowledge and self-efficacy [27]. In contrast, Aharon *et al.* reported that parents with high critical HL are more likely not to vaccinate their children [41].

A. Study Implications

The low vaccination coverage (25.5%) in this study may have an impact on patient safety due to increases the risk of spreading the disease in the healthcare setting. Hence, public health officials should include influenza vaccination coverage as a measure of quality of care as part of a patient safety goal and an infection control strategy [1]. Besides, the identified factors in this study should form the cornerstone of strategies to encourage higher vaccination rates among HCWs. On the other hand, Malaysia has no specific policy in the area of HL. This is in contrast to countries such as the USA and Singapore that have a specific policy or action plan to improve HL [42,43]. The current study has assisted in validating a tool for HL measurement, hopefully will be helpful in estimating the level of HL and the consequences on health outcomes.

B. Study Limitations

This study has several limitations. First, it was an observational cross-sectional study, thus causal relationships could not be inferred. Second, the study population consisted of only nurses and assistant medical officers from two tertiary hospitals in Perak. Thus, the results cannot be assumed to represent all HCWs in Malaysia. Hence, the generalizability of the results may be an issue. Therefore, further studies should include all categories of HCWs from district and private hospitals in Malaysia in order to better understand the vaccination behaviour among HCWs.

C. Study Strengths

The first strength of this study, which was carried out in two tertiary hospitals in Perak, is that seems to be the largest one of its kind in the country. Second, vaccination rates were calculated from documented records, thus minimizing the likelihood of misclassification bias. Third, to the best of our knowledge, this is the first study that has tried to explain the broader dimension of HL related to vaccination among HCWs using validated HL Questionnaire to specifically reflect the topic of influenza vaccination.

V. CONCLUSION

Influenza vaccination coverage was found to be low (25.5%). A multivariate logistic regression showed that the factors associated with influenza vaccination were increasing age (OR 1.04; 95%, CI 1.01,1.08; p= 0.015); working in an emergency department (OR 7.20; 95% CI 1.45,35.69; p= 0.016) or obstetrics & gynaecology department (OR 0.17; 95% CI 0.04,0.85; p = 0.003) compared to other departments group; working as a community nurse compared to an assistant medical officer (OR 8.48; 95% CI 1.33,54.0; p = 0.024); and higher influenza knowledge (OR 1.19; 95% CI 0.99,1.42; p= 0.050). Although the other modifiable factors (behaviour and HL) were non-significant, a theoretically based intervention (the HBM) is more likely to be successful in influencing vaccination behaviour. The above-identified factors should inform future vaccination campaigns and the development of targeted intervention programmes to increase influenza vaccination uptake.

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