FACTORS ASSOCIATED WITH INFLUENZA VACCINATION UPTAKE AMONG HEALTHCARE WORKERS IN TERTIARY HOSPITALS IN PERAK

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FACTORS ASSOCIATED WITH INFLUENZA VACCINATION UPTAKE AMONG HEALTHCARE WORKERS IN TERTIARY HOSPITALS IN PERAK

Abstract

Influenza is the leading cause of respiratory illness worldwide and has a substantial medical, social and economic impact. Healthcare workers (HCWs) are at high risk of infection and can easily spread the disease. Hence, the influenza vaccination is an important preventive action that can be taken to stop the transmission of this disease. However, the uptake among HCWs remains low, and many HCWs were doubt about the effectiveness of the vaccine. Thus, the factors associated with the uptake and the effectiveness of the influenza vaccination need to be studied to understand the reasons behind the poor uptake. Therefore, the objective of this study is to measure the prevalence of influenza vaccination and to determine the factors associated with influenza vaccination uptake and the effectiveness of the vaccination on influenza-related work absenteeism among HCWs in tertiary hospitals in Perak, Malaysia. The study was conducted in two phases. In Phase 1, knowledge (KQ), behavioural determinants (BDQ) and health literacy (HLQ) questionnaires were piloted among 100 HCWs in a tertiary hospital in Selangor, Malaysia to determine content validity, internal consistency and test-retest validity. As a result, the KQ was reduced from 11 to eight items, and the BDQ was reduced from 46 to 40 items. The 14 items in the HLQ were retained. The revised questionnaires had adequate consistency and reliability and were used in Phase 2 of the study. In Phase 2, 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 KQ, BDQ, HLQ and the number of influenza-related sick days in 2017. The vaccination uptake was based on the immunization records for the period between 1 November 2016 and 31 December 2016. The results revealed that the prevalence of influenza vaccination uptake among HCWs was 25.5%. A multivariate logistic regression showed that the factors associated with influenza vaccination were increasing age (Odds ratio (OR) 1.04; 95% confidence interval (CI) 1.01,1.08; p-value 0.015); working in an emergency department (OR 7.20; 95% CI 1.45,35.69; p-value 0.016) or obstetrics & gynaecology (O&G) department (OR 0.17; 95% CI 0.04,0.85; p-value 0.003) compared to other departments, and working as a community nurse compared to an assistant medical officer (OR 8.48; 95% CI 1.33,54.0; p-value 0.024). With regards to absenteeism, there was no significant difference in the mean number of cumulative sick days per person (p=0.3881). However, the total number of workday lost among non-vaccinated was 1.44 times higher than among the vaccinated group. In conclusion, influenza vaccination coverage was found to be low (25.5%). The above-identified factors and the effectiveness of the vaccination should inform future vaccination campaigns and the development of targeted intervention programmes to increase influenza vaccination uptake.

Keywords: effectiveness, healthcare worker, influenza, prevalence, prevention, vaccination

FAKTOR BERKAITAN PENGAMBILAN VAKSINASI INFLUENZA DI KALANGAN PEKERJA KESIHATAN DI HOSPITAL TERTIARI DI PERAK

ABSTRAK

Influenza adalah penyebab utama penyakit respiratori di seluruh dunia dan memberi kesan perubatan, sosial dan ekonomi yang tinggi. Pekerja kesihatan mempunyai risiko yang tinggi untuk mendapat dan menyebarkan jangkitan influenza. Oleh itu, vaksinasi influenza merupakan tindakan pencegahan yang penting untuk mengelak penyebaran penyakit ini. Walau bagaimanapun, pengambilannya di kalangan pekerja kesihatan masih rendah, dan ramai yang masih ragu-ragu tentang keberkesanaannya. Oleh itu, faktor yang berkaitan pengambilan dan keberkesanan vaksin perlu dikaji untuk memahami punca pengambilan vaksin influenza yang rendah. Objektif kajian ini adalah untuk mengukur prevalen pengambilan vaksin influenza, menentukan faktor yang berkaitan dengan pengambilan vaksin influenza dan keberkesanan vaksin dalam mengurangkan ketidakhadiran kerja di kalangan pekerja kesihatan di hospital pakar di Perak. Kajian ini terbahagi kepada dua fasa. Dalam fasa I, kajian rintis telah dijalankan menggunakan borang kaji selidik berkenaan pengetahuan, tingkah laku dan literasi kesihatan yang melibatkan 100 orang pekerja kesihatan di sebuah hospital pakar di Selangor, Malaysia bagi menentukan isi kandungan, ketekalan dalaman dan kebolehpercayaan semula borang kaji selidik ini. Hasil kajian rintis, mendapati 11 soalan tentang pengetahuan telah disemak semula menjadi 8 soalan, 46 soalan tentang tingkah laku telah disemak semula menjadi 40 soalan dan semua 14 soalan tentang literasi kesihatan dikekalkan. Borang kaji selidik yang telah disemak digunakan dalam fasa 2 kajian ini. Fasa 2 adalah kajian secara rentas yang dijalankan di dua hospital pakar di Perak. Kajian ini melibatkan 775 jururawat dan penolong pegawai perubatan yang dipilih menggunakan strategi persampelan mudah rawak. Kajian ini menggunakan borang kaji selidik yang diisi sendiri oleh peserta yang merangkumi sosio-demografi, pengetahuan tentang vaksin influenza, tingkah laku, literasi kesihatan dan bilangan cuti sakit berkaitan influenza pada tahun 2017. Maklumat pengambilan vaksin adalah berdasarkan rekod imunisasi untuk tempoh 1 November 2016 hingga 31 Disember 2016. Keputusan kajian menunjukkan prevalen pengambilan vaksin influenza di kalangan pekerja kesihatan adalah 25.5%. Analisis multivariate menunjukkan faktor yang berkaitan dengan vaksinasi influenza ialah peningkatan umur (OR 1.04; 95% CI 1.01,1.08; p= 0.015), bekerja di jabatan kecemasan (OR 7.20 ; 95% CI 1.45, 35.69, p= 0.016) atau obstetrik & ginekologi (OR 0.17; 95% CI 0.04,0.85; p= 0.003) berbanding dengan jabatan lain, dan bekerja sebagai jururawat komuniti berbanding pembantu pegawai perubatan (OR 8.48; 95 % CI 1.33,54.0; p= 0.024). Berhubung dengan ketidakhadiran kerja, tiada perbezaan yang signifikan dalam purata bilangan hari cuti sakit bagi setiap peserta (p= 0.3881). Walau bagaimanapun, dalam setahun, jumlah hari tidak berkerja di kalangan pekerja kesihatan yang tidak divaksin adalah 1.44 kali lebih tinggi berbanding dengan kumpulan yang divaksinasi (39 hari / 100 subjek dalam kumpulan tidak divaksinasi vs 27 hari / 100 subjek dalam kumpulan yang divaksin). Kesimpulannya, prevalen pengambilan vaksin influenza masih rendah, faktor yang dikenalpasti dan manfaat vaksin dapat membantu kempen vaksinasi di masa depan dalam membangunkan program intervensi yang bersasar untuk meningkatkan pengambilan vaksin.

Kata kunci: keberkesanan, pekerja kesihatan, influenza, prevalen, pencegahan, vaksinasi

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LIST OF SYMBOLS AND ABBREVIATIONS

BDQ	:	Behaviour Determinant Questionnaire
CDC	:	Centers for Disease Control
CITC	:	Corrected items-total score correlation
CVI	:	Content validity index
HBM	:	Health Belief Model
HCW	:	Healthcare worker
HL	:	Health literacy
HLQ	:	Health Literacy Questionnaire
HRPB	:	Hospital Raja Permaisuri Bainun,
ICC	:	Intra-class correlation coefficient
IIV	:	Inactivated influenza vaccine
ILI	:	Influenza-like-illness
KR20	:	Kuder-Richardson 20
LAIV	:	Live attenuated influenza vaccine
MCAR	:	Missing complete at random
MISS	:	Malaysia Influenza Surveillance System
NHMS	:	National Health and Morbidity Survey
NAAL	:	National Assessment of Adult Literacy
NVS	:	Newest Vital Sign
OR	:	Odds Ratio
SARI	:	Severe Acute Respiratory Infection
S-TOFHLA	:	Short Form Test of Functional Health Literacy in Adults
WHO	:	World Health Organization

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CHAPTER 1: INTRODUCTION

About this chapter

Influenza is a major cause of respiratory morbidity and mortality over the years. Hence, influenza vaccination is an essential preventive action to stop influenza transmission. The first chapter discusses the epidemiology of influenza worldwide and among healthcare workers (HCWs), study justification and lastly outlines the objectives of this study.

1.1 Epidemiology of influenza

Influenza is the leading cause of respiratory illness worldwide. It causes a spectrum of respiratory tract infections ranging from mild upper respiratory tract infection to severe pneumonia (Sam, 2015). Besides, life-threatening complications such as secondary bacterial pneumonia, encephalopathy and myocarditis may occur (Sam, 2015).

The World Health Organization (WHO) has estimated that influenza leads to about three to five million cases of severe illness and 290,000 to 645,000 respiratory deaths annually (World Health Organization, 2018). Moreover, in the case of the United States of America (USA) alone, data analysis has shown that influenza was responsible for more than 48.8 million illnesses during the 2017–2018 influenza season (Centers for Disease Control and Prevention, 2018b). These illnesses led to more than 22.7 million medical visits, 959,000 hospital admission, and 79,400 deaths (Centers for Disease Control and Prevention, 2018b).

Previous study has shown that the impacts of influenza infection are more severe in lower- and middle-income countries compared to high-income countries such as the USA (Coleman, Fadel, Fitzpatrick, & Thomas, 2018). However, there is limited data on the actual extent of the influenza burden in regions such as Africa, South America and Asia due to differences in the structure of the healthcare system, healthcare accessibility and financial issues across countries (V. J. Lee et al., 2018).

In the Southeast Asia region specifically, Indonesia has been reported to have an incidence of influenza-associated severe acute respiratory infection (SARI) of 14% (Susilarini et al., 2018), while in Thailand the reported incidence of influenza-associated pneumonia hospitalization is about 10.3% (Simmerman et al., 2009). On the other hand, in Malaysia, the location of this research study, the incidence is lower. For instance, the results of laboratory-based surveillance of seasonal influenza in Malaysia showed that the influenza-positive rate that defined as the proportion of total laboratory samples that tested positive for influenza virus ranged from 3.6% to 7.3% for the period 2011–2016 (Sam et al., 2018). The study by Sam et al. (2018) also found that while changes in the predominant circulating virus occurred at least twice a year, these changes only sometimes led to an increase in influenza transmission. Furthermore, their study showed influenza was present throughout the year; therefore, there was no clear seasonal pattern.

During the H1NI pandemic in 2009, Malaysia reported 15,421 confirmed cases and 92 deaths, although these numbers are considered to be an underestimation (Ong et al., 2010). Moreover, Ong et al. (2010) estimated that the direct healthcare cost per patient hospitalized due to the H1N1 pandemic in Malaysia was high at 510 United States dollars (USD) per capita. To give this figure some context, the cost was 60% greater than the national expenditure on health per capita of USD318 in 2007.

Thus, influenza is a serious disease that responsible for a high medical, social and economic burden. Moreover, healthcare workers (HCWs) are at higher risk of contracting the infection and spreading the disease due to the nature of their work.

1.2 Epidemiology of influenza among healthcare workers

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. All of these HCWs are at increased risk of contracting influenza. Lietz et al. undertook a systematic review of 26 studies and a meta-analysis of 15 studies to assess the occupational risk of acquiring influenza A (H1N1) among HCWs during the 2009 pandemic globally (Lietz, Westermann, Nienhaus, & Schablon, 2016). The researchers found that the pooled prevalence rate of influenza for HCWs was 6.3% and the risk of acquiring an infection was twice as high as that of the control or comparison group (OR 2.08; 95% CI 1.73, 2.51).

Also, in the systematic review conducted by Kuster et al., it was reported that the pooled incidence of influenza among unvaccinated HCWs was 18.7% (95% CI 16%, 22%) per season, of which 7.5% were symptomatic (Kuster et al., 2011). Their study showed that the risk of developing influenza among HCWs was higher than among non-HCW adults. However, they also showed that the rate of asymptomatic HCWs was higher than that among non-HCW adults. These seemingly contradictory results could be due to HCWs having had cumulative exposure to influenza over time as compared to non-HCW adults, whereby the prior gaining of immunity reduces symptom severity.

Healthcare workers are not only classed as high risk in terms of contracting the infection, but also in terms of their ability to spread the virus to vulnerable patients, their colleagues and their own family members. In a Canadian study conducted between 2006 and 2012, healthcare transmission was associated with 17.3% of laboratory-confirmed influenza cases among hospitalized patients (Taylor et al., 2014). Indeed, HCWs have been identified as a primary source of infection in many influenza outbreaks.

In addition to its impact on morbidity and mortality, an influenza outbreak in a healthcare facility is also associated with increased work absenteeism and disrupts of healthcare services as well as a high expenditure on treatment, prophylaxis, contact-tracing and infection-control measures. Therefore, to prevent both the contraction and the transmission of the influenza infection and its associated costs, HCWs are expected to be vaccinated against the virus.

1.3 High-risk groups for influenza

High-risk groups for influenza are those that have a higher risk of becoming infected and those that are at higher risk of developing influenza complications such as hospitalization or death. The former includes HCWs because they have a higher risk of contracting influenza than those not working in the healthcare sector due to the nature of their job that involves treating sick patients (Kuster et al., 2011; Lietz et al., 2016). It is crucial to study the HCW group in view of the fact that they can spread the disease to patients, colleagues and family members. The groups that have increased risk of developing complications are the elderly, patients with other medical illnesses, pregnant lady and children who are less than five years of age (World Health Organization, 2012).

1.4 Effectiveness of influenza vaccine

The influenza vaccine is known to be effective in reducing ILI symptoms, work absenteeism, laboratory-confirmed influenza, hospitalization and mortality among, children, elderly, pregnant woman and HCWs (World Health Organization, 2015). The influenza vaccination benefits are commonly reported in temperate regions with clear seasonal influenza (Ferroni & Jefferson, 2011; Michiels, Govaerts, Remmen, Vermeire, & Coenen, 2011; Zaffina et al., 2019). However, there is limited data on the effectiveness of the influenza vaccine among HCWs in tropical regions (World Health Organization, 2015). This is an issue of particular importance as the influenza season continues throughout the year in tropical countries (Sam et al, 2018). One of the main concerns is the waning of immunity following the months of vaccination because this results in a decrease in the vaccination benefit (World Health Organization, 2015). For example, Ferdinands et al. (2017) conducted a study among patients aged more than nine years old that presented with acute respiratory illness in the US and observed significant decreasing vaccine effectiveness with increasing time since vaccination (Ferdinands et al., 2017). Hence, vaccine effectiveness in tropical countries such as Malaysia requires further investigation. Due to cost and time limitation, we decided that measuring influenza-related work absenteeism would be the most suitable and feasible way to be used as a proxy for the effectiveness of the influenza vaccination among HCWs in this study. This will be further elaborated in Chapter 2

1.5 Influenza vaccination policy and programmes

Realizing the importance of the influenza vaccination, the WHO has recommended that vaccination of HCWs should be part of the infection control policy in healthcare facilities (World Health Organization, 2012). In Malaysia, a national influenza policy was introduced in 1988 (Dwyer et al., 2013). However, influenza vaccination is funded only for front-line HCWs (Disease Control Division Ministry of Health Malaysia, 2006). It is also a voluntary programme, i.e., HCWs can opt-in or out of the programme at any time. Unlike in other countries, there is no population-wide influenza vaccination programme. Other at-risk groups are advised to have a vaccination, and the vaccines are available via the private healthcare sector. Malaysia located in the north of the equator in terms of location (World Atlas, 2017). However, the decision to use Northern or Southern formulation for vaccinations is following the WHO recommendation, which is based on the currently circulating virus (Sam, 2015; World Health Organization, 2017). As there is no clear influenza season, vaccinations tend to take place throughout the year (Sam et al, 2018).

The main objectives of the influenza vaccination programme in Malaysia are to:

1. Reduce the morbidity of healthcare workers due to influenza infection;
2. Reduce the risk of patients cared for by healthcare workers contracting influenza infection; and
3. Provide a mechanism of influenza vaccination during an influenza pandemic in preparation for a pandemic (Disease Control Division, Ministry of Health, 2006).

Given that a high vaccination rate is a prerequisite for effective disease control, studies have attempted to quantify the coverage of the influenza vaccination programme in Malaysia. For instance, a study conducted in University Kebangsaan Malaysia Medical Centre, which is a teaching hospital, reported influenza vaccination coverage among HCWs of 7.2%–23.8% from 2009 to 2011 (Zetti Zainol Rashid et al., 2015). The extent of coverage among HCWs in public hospitals is varied, as evidenced by Marzo et al, who found influenza vaccination status is high in community nurses (86%) but low in hospital nurses (52%) in Muar, Johor (Marzo, 2016). Similarly, it has been revealed that there is a 51.4% influenza vaccination uptake rate among HCWs in private and public hospitals in areas of the Klang Valley (Hudu, Harmal, Osman Malina, & Zamberi Sekawi, 2016). These findings indicate that, despite a policy of offering free influenza vaccinations for HCWs, the vaccination uptake among this group has generally been low. There seem to be several reasons for the low uptake, which will be discussed in Chapter 2.

Monitoring of the vaccination programme for HCWs is based on the down-up mechanism. In this mechanism, public health officials from hospitals or district health offices are required to send a monthly return to headquarters on current vaccine usage or any adverse event following immunization (Disease Control Division Ministry of Health Malaysia, 2015). Nevertheless, there is limited data on the effectiveness of this vaccination programme.

1.6 Problem statement and justification for the study

Influenza is the leading cause of respiratory illness worldwide. In the case of the USA, it has been estimated that the influenza burden during six influenza seasons (2010–2011 to 2015–2016) resulted in 9.2 million to 35.6 million influenza-related illnesses and 140,000 to 710,000 influenza-related hospitalizations (Rolfes et al., 2018). For the same period of influenza seasons in Malaysia, it has been reported that year-round influenza transmission with an influenza-positive rate ranged from 3.6% to 7.3% (Sam et al., 2018). Given that influenza cases are common and the impact of future pandemics is potentially catastrophic, there is unquestionably a need to study the uptake and effectiveness of the influenza vaccination.

The motivation for studying the uptake of influenza vaccination among HCWs is due to their high risk of contracting the disease and spreading it to patients and family members. The Ministry of Health in Malaysia funds the influenza vaccination for front-line HCWs to prevent the infection and reduce work absenteeism related to influenza (Disease Control Division Ministry of Health Malaysia, 2006). However, coverage among HCWs remains poor. A recent Malaysian study reported that influenza vaccination uptake among HCWs in Malaysia is just 51% (Hudu et al., 2016).

Understanding the reasons for the hesitation of individuals to take vaccination is important to achieve and maintain high vaccination coverage. Thus the sociodemographic characteristics, knowledge about the influenza vaccination, behavioural determinants and health literacy (HL) require further exploration in the Malaysian setting. Besides, there is a lack of data on the effectiveness of the influenza vaccination among HCWs. A previous study that reviewed this issue looked at the effectiveness of the influenza vaccination on healthy adults, but did so under the assumption that most HCWs are healthy adults (Ng & Lai, 2011; Osterholm, Kelley, Sommer, & Belongia, 2012), which does not allow for nuances in this population group.

The novelty of this study lies in its attempt to identify and fill the gaps in knowledge about the factors associated with influenza vaccination uptake and the effectiveness of the vaccination among HCWs in Malaysia. Identifying the factors associated with influenza vaccination among HCWs will assist in the planning of targeted interventional programmes to increase coverage, thereby improving the health and well-being of both HCWs and patients as well as achieving cost savings. The findings will also provide objective, evidence-based data for policy formulation in term of implementation of influenza vaccination for the high-risk group.

1.7 Significance of the study

The prevalence and effectiveness of the influenza vaccination in Malaysia have been under-studied. It is therefore difficult to engage policymakers and persuade them to invest more funds into interventional vaccination programmes. This research study is therefore important as it aims to investigate the level of knowledge, behaviours and HL among HCWs to identify the reasons for their low uptake of the influenza vaccination. More importantly, the findings of this study will inform policymakers about the prevalence of influenza vaccination uptake among HCWs in Malaysia and hopefully help to strengthen the government's health prevention programme by enabling a focus on targeted interventional strategies that are based on knowledge, behaviour and HL.

Moreover, it clarifies why there is a need to assess the HL of HCWs, and thereby helps in determining the potential consequences of limited HL from an occupational perspective. In addition, it is hoped that the findings regarding the effectiveness of the influenza vaccination programme on work absenteeism will sensitize other government departments (e.g., police, immigration) to the issue and encourage them to initiate such a programme.

1.8 Research questions

1. Are there any validated tools that can be used to evaluate knowledge about, behaviours towards and health literacy on influenza vaccination?
2. What is the prevalence of influenza vaccination uptake among healthcare workers?
3. What are the sociodemographic characteristics and levels of knowledge, behaviours and health literacy, related to influenza vaccination among healthcare workers?
4. Is there an association between the sociodemographic characteristics, knowledge, behaviours and health literacy of healthcare workers and their uptake of the influenza vaccination?
5. Does influenza vaccination reduce work absenteeism among healthcare workers?

1.9 Study objectives

1.9.1 General objective

The general objective of this study is to determine the prevalence of and the factors associated with influenza vaccination uptake and the effectiveness of influenza vaccination among healthcare workers.

1.9.2 Specific objectives

To achieve the general objective of this study, we set the five following specific objectives:

1. To validate the Knowledge, Behavioural Determinants and Health Literacy Questionnaire related to influenza vaccination in Malaysia;
2. To determine the prevalence of influenza vaccination uptake among healthcare workers
3. To describe the sociodemographic characteristics, knowledge, behavioural determinants and health literacy regarding influenza vaccination among healthcare workers;
4. To determine the association between the sociodemographic characteristics, knowledge, behavioural determinants and health literacy of healthcare workers and their uptake of the influenza vaccination;
5. To determine the effectiveness of the influenza vaccination on influenza-related work absenteeism among healthcare workers.

1.10 Thesis outline

This thesis is divided into six chapters:

- Chapter 1 is the introductory chapter and provides a general overview of the research topic, problem statement and the research objectives.
- Chapter 2 presents the literature review on the research topic. The review covers the influenza virus and vaccine, prevalence, knowledge, behavioural determinants and HL related to influenza and influenza vaccination. It also describes the methods that can be used to measure these variables. In addition, it discusses the effectiveness of the influenza vaccination among HCWs and the conceptual framework.
- Chapter 3 describes the methods and materials used in this study, which is conducted in two phases. Phase 1 involves testing the psychometric components of the knowledge, behavioural determinants and HL questionnaires related to influenza vaccination. Phase 2 is a cross-sectional study conducted to measure the factors associated with influenza vaccination uptake and the effectiveness of the influenza vaccination on work absenteeism.
- Chapter 4 presents the results of Phase 1 and Phase 2, according to the study objectives.
- Chapter 5 discusses the findings, and some comparisons are made with the literature. It also highlights the implications, strengths and limitations of the study.
- Chapter 6 is the final chapter of the thesis. It summarizes the key findings of the study and makes some recommendations for future studies.

1.11 Chapter summary

Influenza is the leading cause of respiratory illness worldwide that can have a substantial medical, social and economic impact. HCW are at high risk of infection and can easily spread the disease due to the nature of their work. Hence, the influenza vaccination is an essential preventive action that can be taken in order to stop the transmission of this disease. However, the uptake among HCWs remains low and many HCWs were doubt about the effectiveness of the vaccine. This study aims to investigate the prevalence and factors associated with the influenza vaccination uptake. Hence, future vaccination program should have targeted the identified factors to ensure adequate vaccination coverage. We also study the effectiveness of influenza vaccination in reducing work absenteeism.

CHAPTER 2: LITERATURE REVIEW

About the chapter

This chapter discusses the literature review of the characteristic of influenza virus and vaccine, the prevalence of influenza vaccination among HCWs, factors associated with influenza vaccination uptake and the effectiveness of the influenza vaccination. This chapter also describes the methods that can be used to measure these variables. The subsequent section covers literature on the conceptual framework of this study.

2.1 Characteristics of the influenza virus

In order to prevent influenza via vaccination and other means, it is essential to recognise the influenza virus and how it causes the disease. Influenza is caused by ribonucleic acid viruses from genera of the Orthomyxoviridae family (World Health Organization, 2012). There are four types of influenza virus: A, B, C and D (World Health Organization, 2018). Influenzas A and B cause seasonal epidemics, Influenza C has low infectivity and causes a mild respiratory illness. Whereas, influenza D affects cattle and is not known to circulate in humans. The virus has two surface proteins: haemagglutinin (HA) and neuraminidase (NA) (Sam, 2015). There are 18 different haemagglutinin subtypes (H1 through H18) and 11 neuraminidase subtypes (N1 through N11) (Sam, 2015). Influenza A subtypes H1N1 and H3N2 are currently circulating among humans. Influenza B viruses are categorized by strain and lineage. A study on circulating viruses found that, in Malaysia, influenza B belongs to one of two lineages: B/Yamagata or B/Victoria (Sam, 2015). However, influenza A is more common (55.4%) than influenza B (44.6%) in Malaysia (Sam et al, 2018).

An important characteristic of influenza is its ability to undergo ‘genetic drift’. This means that the virus continuously mutates and thus escapes population immunity. In other words, the population is always susceptible to a new strain of circulating virus (Sam, 2015). Another unique characteristic of influenza virus is its capability to undergo 'genetic shift', meaning when a strain of influenza A virus completely replaces one or more of its gene segments with the homologous segments from another influenza A strain. This new virus may then cause pandemics worldwide against which humans have no immunity (Sam, 2015).

Given the extreme mutability of the virus, the yearly influenza vaccination has been introduced by the WHO (World Health Organization, 2012). However, there is limited compliance with this requirement for the high-risk groups because of the countries high financial and costs. Asma et al. in their study among HCWs in Turkey reported that half of the non-vaccinated HCWs found the yearly vaccination uncomfortable and that it negatively affected their schedule of regular vaccination (Asma et al., 2016). The implementation of the uptake of yearly influenza vaccinations among HCWs is yet to be explored in the Malaysian setting.

2.2 Transmission of the influenza virus

The influenza virus is spread via airborne, direct or indirect contact (Dash et al., 2004). The airborne spread of the virus occurs when an infected person sneezes, spits or coughs, whereas the virus spreads via direct contact when an infected person sneezes mucus straight into another person's mouth, nose or eyes. On the other hand, indirect transmission happens when there is bodily contact with a contaminated surface.

The term 'viral shedding' is used for the period during which a person can infect another person. In a healthy adult, viral shedding increases sharply between 0.5 and 1 day of contracting the influenza virus, consistently peaks on day two and can persist for five days (Carrat et al., 2008). However, in an immunocompromised individual, viral shedding can continue for more than two weeks (Carrat et al., 2008).

The multiple portals of entry in which the disease can be transmitted allow it to spread rapidly and enormous resources are required to deal with an outbreak or pandemic, which has a negative economic impact (Ong et al., 2010; Simmerman et al., 2006). It therefore seems logical that the influenza vaccination should be promoted as an effective preventive measure.

2.3 Clinical symptoms of influenza

People with influenza may experience symptoms such as high fever, runny nose, cough, sore throat, headache, severe malaise and muscle and joint pain (World Health Organization, 2018). Secondary bacterial pneumonia, which is commonly caused by *Staphylococcus aureus, Streptococcus pneumoniae or Haemophilus influenzae*, is a frequent complication of influenza, particularly in individuals with certain chronic diseases or older people (World Health Organization, 2012).

The incubation period for the influenza virus is generally 1 to 4 days before the onset of symptoms, and an individual can remain infectious for five days or more after that. However, only 50% of infected persons are symptomatic, making the diagnosis of infected HCWs difficult (Dash et al., 2004). Moreover, studies have shown that HCWs continue to work while they have the illness or return to work earlier than they ideally should and thus pose a higher risk of spreading the virus to patients and colleagues alike (Gianino, Politano, Scarmozzino, & Charrier, 2017; Weingarten, Riedinger, Bolton, Miles, & Ault, 1989). In other words, HCWs can become a potential vector for influenza, where they act as an agent of disease transmission.

2.4 Diagnosis of influenza

In the past, healthcare providers may have felt that influenza was challenging to diagnose, which may, in turn, have contributed to the neglect of influenza diagnosis (Sam, 2015). One reason for this perceived difficulty is that diagnosis requires laboratory confirmation because clinical diagnosis alone cannot distinguish influenza from other infectious diseases. Previously, influenza was detected by using viral culture and immunofluorescence assay. However, the increasing availability of real-time polymerase chain reaction (PCR) and rapid antigen detection test kits has made the diagnosis of influenza an easier task (Disease Control Division Ministry of Health Malaysia, 2015; Sam, 2015; Yoong et al., 2019). The diagnostic test results produced by these newer methods provide virology data that includes the type and subtype of the influenza virus.

Nevertheless, such technologies come with a cost. For instance, it has been estimated that during the Malaysian influenza pandemic of 2009, the cost for real-time PCR constituted 13.6% of the total direct healthcare cost (Ong et al., 2010). This highlights the high financial burden associated with diagnosing influenza. Hence prevention rather than treatment, i.e., through vaccination, should be a government priority.

2.5 The Malaysia Influenza Surveillance System

The Malaysia Influenza Surveillance System (MISS) was initiated in 2004 to collect data via disease-based and laboratory-based surveillance (Disease Control Division Ministry of Health Malaysia, 2004). In disease-based surveillance, cases of influenza-like-illness (ILI) are reported by so-called sentinel sites that are comprised of government and private clinics. Respiratory samples are obtained from ILI cases and sent to the National Public Health Laboratory in Sungai Buloh, Selangor to detect whether influenza is present. Following the influenza pandemic of 2009, surveillance of SARI was added to the scope of the MISS from May 2009. In SARI surveillance, data is collected from selected sentinel government and private hospitals. From March 2013, respiratory samples from SARI cases were sent to the Institute for Medical Research in Kuala Lumpur for laboratory-based surveillance. Then, in 2016, the MISS was revised according to the WHO *Global Epidemiological Surveillance Standards for Influenza* (World Health Organization, 2013a), which outline the minimum standards for an influenza surveillance system (Disease Control Division Ministry of Health Malaysia, 2015). Since then, the sentinel sites for influenza surveillance have been optimized to include SARI hospitals and 15 ILI clinics throughout the country.

Influenza surveillance data provide critical knowledge on the distribution of influenza types and seasonality to support the uptake and timing of influenza vaccination (World Health Organization, 2012). Laboratory surveillance conducted in Malaysia during the period 2011–2016 shows there is a low level of influenza transmission throughout the year (Sam et al, 2018). This finding supports the need for continued year-round influenza vaccination using the most recent formulation.

2.6 Antiviral treatments for influenza

There are two classes of antiviral drugs for influenza:

1. Neuraminidase inhibitors (oral oseltamivir, intravenous peramivir znd inhaled zanamivir)
2. Transmembrane ion channel (M2 protein) inhibitors (rimantadine and amantadine).

Neuraminidase is the first-line treatment recommended by the WHO (World Health Organization, 2012). This drug is active against influenza A and influenza B. Unfortunately, the currently circulating viruses are resistant to M2 protein inhibitors (World Health Organization, 2012). Even though some treatments for influenza are available, prevention is still better than cure. Therefore, in this study, we investigate the implication of influenza vaccination in preventing the influenza infection and reducing the work absenteeism.

2.7 Types of influenza vaccine

Influenza vaccination remains the most effective way of preventing influenza infection (Ferroni & Jefferson, 2011; Jefferson, Rivetti, C, Demicheli, & Ferroni, 2012; Kuster et al., 2011). The antigenic compositions of the vaccines are revised twice annually based on information on circulating viruses obtained by the WHO Global Influenza Surveillance and Response System (GISRS) (World Health Organization, 2013a). This is done to optimize efficacy against current strains in both the northern and southern hemisphere.

There are two types of influenza vaccine available: inactivated influenza vaccine (IIV) and live attenuated influenza vaccine (LAIV) (World Health Organization, 2012).

The former is available in two preparations: trivalent inactivated vaccine (IIV3) and quadrivalent inactivated vaccine (IIV4). The IIV3 preparation contains two influenzas A strains (H1N1 and H3N2) and one influenza B strain, whereas IIV4 contains an additional B virus. For example, the 2016–2017 influenza vaccines available in Malaysia protect against the following strains (Centers for Disease Control and Prevention, 2018c):

IIV3:

- an A/California/7/2009 (H1N1) pdm09-like virus
- an A/Hong Kong/4801/2014 (H3N2)-like virus
- a B/Brisbane/60/2008-like virus

IIV4:

- the above three viruses and an additional B virus called the B/Phuket/3073/2013-like virus

Inactivated influenza vaccines are made from killed viruses, which means they do not cause illness and at the same time, provide protection against influenza viruses (World Health Organization, 2012). The formulation also contains some adjuvants such as oil-in-water adjuvants or virosomes to enhance immunogenicity. Also, preservatives such as thimerosal are added in multi-dose vials to prevent microbial growth. Single-vial thimerosal-free vaccines are available but at a higher cost. Inactivated influenza vaccines are administered via injection intramuscularly into the deltoid muscle (for vaccinees that is more than 1-year-old) or the anterolateral aspect of the thigh (for vaccinees that is 6–12 months old). On the other hand, LAIV preparations are made from weakened viruses and administered intranasally.

2.7.1 Adverse effects of influenza vaccination

One of the major concerns that have been expressed by HCWs concerning their decision to have an influenza vaccination is the safety of the influenza vaccination (Hudu et al., 2016; Hulo, Nuvoli, Sobaszek, & Salembier-Trichard, 2017). Like any other medical intervention, influenza vaccination is not risk-free. Minor post-injection adverse effects can occur. Pain and swelling at the injection site are the common reported local reaction adverse events (Nichol et al., 1995; Norton, Scheifele, Bettinger, & West, 2008). Norton et al. (2008) also reported systemic adverse effects include tiredness, muscle pain and fever.

In 2012, a Cochrane review of vaccinations for preventing influenza in healthy adults was conducted by Jefferson et al. (2012). The main reported adverse effects included local tenderness and pain (RR 3.11; 95% CI 2.08, 4.66), myalgia (RR 1.54; 95% CI 1.12, 2.11) and skin rash (RR 4.01; 95% CI 1.91, 8.41) (Jefferson et al., 2012). A number of serious adverse effects were also described, including oculorespiratory syndrome (bilateral conjunctivitis, wheezing, cough, dyspnoea, hoarseness, dysphagia,) as well as Guillain-Barré syndrome (rapidly progressing symmetric paralysis with usually spontaneous resolution) estimated at 1.6 cases per one million vaccinations. No evidence was found for other demyelinating diseases (Jefferson et al, 2012). This review reported that previous studies showed that post-injection adverse effects occur but rarely severe. These adverse effects might contribute to the refusal to have an influenza vaccination (Hakim, Gaur, & McCullers, 2011).

2.8 Prevalence of influenza vaccination uptake among healthcare workers

The prevalence of influenza vaccination among HCWs varies widely across countries. A comparison of the vaccination coverage was made recently, in which it was found that high-income countries such as the USA, Canada, Australia and Japan have high influenza vaccination coverage (Dini et al., 2018). Figure 2.1 shows the influenza vaccination coverage among HCWs worldwide between 2006 and 2015.

Figure 2.1: Vaccination coverage against influenza among HCWs for the period 2006–2015
Source: Dini et al. (2018)

As shown in Table 2.1 below, research studies have been undertaken on vaccination coverage against influenza globally from 2007 to 2018. In the USA, where influenza vaccination of HCWs is mandatory, the reported vaccination coverage was as high as 82% (Lindley et al., 2014). The latest survey by Black et al, the influenza vaccination coverage in the US was 78.4% (Black et al., 2018). Canada, with similar mandatory policy also showed good coverage as high as 73% (Hussain et al., 2018).

In contrast, in Europe, influenza vaccination coverage among HCWs is low; generally less than 30% (Dini et al., 2018). Similarly, a technical report on 17 member states of the European Union (EU) showed that the median influenza vaccination coverage among HCWs in 2014–2015 was 25.7% (European Centre for Disease Prevention and Control, 2017). In the case of Italy, an EU member state, a systematic review of 15 studies and a meta-analysis of six studies revealed that the pooled coverage of influenza vaccination among nurses was even lower at 13.47% (La Torre et al., 2011). On the other hand, 22% vaccination uptake has been reported among Australian HCWs (Holly Seale, Leask, & MacIntyre, 2009).

As regards Asian HCWs, a multi-centre study reported the vaccination uptake rates are 35.6% in Hong Kong, 33.5% in Brunei and 69.5% in Singapore (Kwok et al., 2019). Another study in Singapore reported the uptake is significantly higher at 82% (Kwok et al., 2019; Kyaw et al., 2018). In other Asian countries, such as India, China, Saudi Arabia and South Korea, the vaccination uptake was 4.4%, 9.5%, 55.9% and 83% respectively (Alenazi, Hammad, & Mohamed, 2018; Bali et al., 2013; Ko et al., 2017; Zhou et al., 2013). Meanwhile, in Malaysia, the uptake among HCWs is 51% (Hudu et al., 2016).

Table 2.1: Vaccination Coverage against Influenza among Healthcare Workers (2007–2018 Influenza Seasons)

Reference	Country/Region	Influenza season	No. and category of respondents	Vaccination coverage rate
Seale et al. (2010)	Australia	2007	1079 HCWs	22%
Bali et al. (2013)	India	2010	1421 HCWs	4.4%
Zhou et al. (2013)	China	2011	576 HCWs	9.5%
Hudu et al. (2016)	Malaysia	2013	527 HCWs	51%
ECDC (2014)	Europe	2014	-	25.7%
Hussain et al. (2018)	Canada	2014	896 HCWs	73%
Hulo et al. (2017)	France	2014	344 HCWs	18%
Alenazi et al. (2018)	Saudi Arabia	2014	204 HCW	55.9%
Lindley et al. (2014)	USA	2014	-	82%
Ko et al. (2017)	South Korea	2014	942 doctors	83%
Kyaw et al. (2018)	Singapore	2015	3873 HCWs	82%
Asma et al. (2016)	Turkey	2015	642 HCWs	9.2%
Black et al. (2018)	USA	2018	2265 HCWs	78.4%
Kwok et al. (2019)	Hong Kong Brunei Singapore	Previous vaccination	1386 nurses 1082 nurses 1503 nurses	35.6% 33.5% 69.5%

2.9 Factors associated with influenza vaccination uptake among healthcare workers

Numerous factors are associated with influenza vaccination. They can be modifiable (knowledge, behaviour and HL) and non-modifiable (sociodemographic). The main factors are discussed in detail below.

2.9.1 The association between sociodemographic characteristics and influenza vaccination

2.9.1.1 Age

Increasing age is positively associated with influenza vaccination uptake among HCWs, as evidenced by multiple studies (Asma et al., 2016; Clark, Cowan, & Wortley, 2009; Hulo et al., 2017; Kyaw et al., 2018; P. Lu, O'Halloran, Ding, Williams, & Black, 2016; Nowalk et al., 2008). In the case of Singapore (Kyaw et al., 2018) and Turkey (Asma et al., 2016), increasing age is associated with a higher likelihood of having a vaccination. In one study in France, an age more than 40 years old is associated with higher vaccination (OR 1.93; 95% CI 1.02,3.67; $p = 0.044$) (Hulo et al., 2017), while in another study in the USA an age of more than 50 years increases the likelihood of having a vaccination (P. Lu et al., 2016). However, a study in South Australia reported that younger age is an independent predictor of seasonal influenza vaccination ($p < 0.001$) (Tuckerman, Collins, & Marshall, 2015).

In Malaysia, influenza vaccination uptake was found to be significantly associated with increasing age (OR 12.49; 95% CI 6.27, 24.86; $p < 0.001$) among HCWs regardless of job category (Zetti Zainol Rashid et al., 2015). However, a study in Klang Valley (Hudu et al, 2016) did not find an association between age and vaccination. Both studies in Malaysia were limited with small sample size. Given the conflicting results and study limitations, there is a need to investigate further the relationship between age and vaccination intake among HCWs in Malaysia using a larger sample size.

2.9.1.2 Gender

Gender has been associated with the uptake of influenza vaccination in a few studies. However, the reported effect varies. For instance, the female gender is associated with influenza vaccination uptake (OR 9.11; 95% C1 1.26, 65.72) (Qureshi, Hughes, Murphy, & Primrose, 2004). In contrast, other studies have found that being male increase the uptake of vaccination (Alshammari, Yusuff, Aziz, & Subaie, 2019; Asma et al., 2016; Falomir-Pichastor, Toscani, & Despointes, 2009; Schmid, Rauber, Betsch, Lidolt, & Denker, 2017). A systematic review of 470 articles also reported being male as a factor associated with vaccination among HCWs (Schmid et al., 2017). Meanwhile, a Malaysia-based study found no evidence for a gender difference in influenza vaccination uptake (Zetti Zainol Rashid et al., 2015). However, the study was conducted only among 106 vaccinated and 105 non-vaccinated HCWs in a teaching hospital in Kuala Lumpur. Therefore, further research using a larger sample size is needed to investigate the relationship between gender and influenza vaccination uptake in Malaysia.

2.9.1.3 Ethnicity

Several studies have reported on the influence of ethnicity in predicting influenza uptake. For example, a study conducted in Canada among 896 HCWs revealed that HCWs of black ethnicity have lower odds of having an influenza vaccination compared with those of European ancestry (OR 0.44; 95% CI 0.26, 0.75) (Hussain et al., 2018). However, the study showed no significant differences in vaccination uptake among HCWs from South Asia, East Asia, Southeast Asia or the Middle East. In contrast, a study among 1,310 registered nurses in the USA reported no significant difference in vaccination uptake by race or ethnicity (Clark et al., 2009). As Malaysia is a multiracial country, there is a need to explore this factor to determine whether it has an influence on vaccination uptake in the country in order to target vaccination programmes effectively.

2.9.1.4 Educational background

Educational background affects influenza vaccination, but the results reported by previous studies are contradictory. For example, Barbadaro et al. (2013) used data from the survey "Health and Health Care Use in Italy," which comprised interviews of 5,336 HCWs. The researchers reported that higher education is associated with lower vaccination uptake (OR 0.65; 95% CI 0.50,0.83) (Barbadoro et al., 2013). Conversely, Lu et al. (2016), who analysed data from the 2013 and 2014 National Health Interview Surveys conducted in the USA concluded that higher education is associated with increased vaccination uptake. In a similar vein, a study in Hong Kong found that the odds of having a seasonal influenza vaccination is four times higher for nursing students studying on master's programme compared to those studying on the higher diploma (OR 4.01; 95% CI 1.09, 14.73) (Cheung, Ho, & Lam, 2017). In Malaysia, it seems that researchers are yet to investigate the relationship between educational background and influenza vaccination uptake and hence, there is a clear research gap that needs to be filled.

2.9.1.5 Job category

As mentioned previously, the term HCW covers many job categories such as doctors, nurses, assistant medical officers and allied health and support service staff and the like. Previous studies have investigated all categories of HCW or have focused on a specific group. Vasilevska et al in their systematic review that include thirty-seven studies evaluating a variety of vaccines (against hepatitis B, influenza, pertussis, smallpox and anthrax) reported that working as a nurse were less likely to be vaccinated (pooled OR 0.66; 95% CI 0.46, 0.97), however the result was suggestive of publication bias (Vasilevska, Ku, & Fisman, 2014). It has been reported that physicians (OR 4.2; 95% CI 1.4, 13.2) and hospital support service staff (OR 1.8; 95% CI 1.3, 2.4) have significantly higher odds of vaccination uptake than nurses in Canada (Hussain et al., 2018).

In contrast, according to the results of research conducted in Beijing (OR 1.6; 95% CI 1.31, 2.20) (H. Seale et al., 2010) and Saudi Arabia (OR 1.461; 95% CI 0.65, 3.24) (Alshammari et al., 2019) nurses are more likely to be vaccinated compared to doctors.

Meanwhile, a study in Singapore found that being a medical staff member (OR 0.36; 95% CI 0.26, 0.51) or an allied health staff member (OR 0.58; 95% CI 0.45, 0.76) are significantly less likely to have an influenza vaccination compared to nursing staff (Kyaw et al., 2018). Moreover, another study found that nurses, midwives, other qualified and technical staff, and clinical support staff are significantly less likely to have an influenza vaccination compared to doctors in the United Kingdom (Mytton, O'Moore, Sparkes, Baxi, & Abid, 2013).

From the literature review, the results are varying, and it seems that previous studies commonly investigated nurses as a group in general. Thus there is a need to investigate the different categories of the nurse, such as sisters, ward managers, registered nurses and community nurses, and their associations with influenza vaccination.

2.9.1.6 Department

Studies have also shown that the department in which the HCW works affects vaccination uptake. In Turkey, a cross-sectional study found that working in an internal medicine department significantly increases vaccination compliance ($p < 0.05$) (Asma et al., 2016). Meanwhile, a cross-sectional study in Beijing reported that working in an emergency department is a significant predictor of having an influenza vaccination (H. Seale et al., 2010).

In Malaysia, a descriptive study by Hudu et al reported that vaccination uptake rate was found to be higher among HCWs in internal medicine department (78.6%) followed with emergency medicine department (76.8%) (Hudu et al., 2016). However, the study did not further investigate the association between department and vaccination uptake. Therefore, there is a need to investigate further the relationship between place of work and vaccination status in Malaysia order to identify the high-risk groups and target the vaccination programmes effectively.

2.9.1.7 Income

A study in Japan found that yearly income is a predictor for influenza vaccination uptake (Wada & Smith, 2013). The study reported that an annual household income of USD50,000 to USD100,000 compared to one of USD0 to USD50,000 (OR 1.30; 95% CI 1.07, 1.54) is positively associated with influenza vaccination intent. In Malaysia, the relationship between income and influenza vaccination uptake hasn't been investigated. Hence, this factor is yet to be investigated in the Malaysian setting.

2.9.1.8 Marital status

The results of a research study among 299 nursing students in Israel found that unmarried nurses are less likely to have an influenza vaccination in comparison to married nurses (Shahrabani et al., 2009). Similarly, data from the 2013 and 2014 National Health Interview Surveys in the USA indicates that having never been married is independently associated with a decreased likelihood of vaccination among HCWs (P. Lu et al., 2016). In Malaysia, there seems to be scant research on the relationship between marital status and influenza vaccination. Hence there is a need to investigate this issue more thoroughly.

2.9.1.9 The association between vaccination needs and influenza vaccination

Two prior studies have reported that having a chronic disease is a statistically significant predictor for vaccination uptake ($p < 0.005$) (Asma et al., 2016; Zhou et al., 2013). Also, those suffering from diabetes (OR 2.07; 95% CI 1.19, 1.69), cardiovascular diseases (OR 1.48; 95% CI 1.11, 1.96) and chronic obstructive pulmonary disease (OR 1.95; 95% CI 1.31, 2.89) are more likely to be vaccinated (Barbadoro et al., 2013).

In addition, it has been reported that living with a person who is over 65 years old significantly increases vaccination uptake ($p < 0.05$) (Asma et al., 2016). However, the study found no association with living with a pregnant lady, a child who is less than two years old or with a person with a chronic medical condition. This finding contrasts with that of Dorribo, Lazor-Blanchet, Hugli and Zanetti who stated that pandemic influenza vaccination uptake is strongly associated with living with a pregnant woman or with an infant (OR 5.83; 95% CI 2.30, 14.80) (Dorribo, Lazor-Blanchet, Hugli, & Zanetti, 2015). Similarly, Wada & Smith (2013) reported participants living with children: one compared with none (OR 1.37; 95% CI 1.11, 1.65) and more than two compared with none (OR 1.21; 95% CI 0.96–1.50) are more likely to be vaccinated. Meanwhile, Kyaw et al. (2018) in Singapore reported living with family members who are less than 16 years (OR 0.69; 95% CI 0.56, 0.86) significantly associated with influenza vaccine compliance.

In short, previous studies show that the need for influenza vaccination is influenced by living with a person in a high-risk group of getting influenza complications and the presence of chronic disease in the participant. Thus vaccination need is a factor that needs to be further investigated in the context of Malaysia.

2.9.1.10 The association between lifestyle behaviour (smoking) and influenza vaccination

Previous research by Barbadoro et al among 5,336 HCWs in Italy has shown that smokers (OR 1.40; 95% CI 1.15, 1.70) and former smokers (OR 1.54; 95% CI 1.24, 1.91) have an influenza vaccination more frequently than never-smokers (Barbadoro et al., 2013). In contrast, in a Japan-based study, it was found that smoking is negatively associated with influenza vaccination uptake (current smokers compared with non-smokers: OR 0.79; 95% CI 0.61, 0.98) (Wada & Smith, 2013).

In summary, from the literature review, the prevalence and relationship between influenza vaccination and sociodemographic characteristics have generally been well studied. However, while there is some consistency in the findings of these studies, the robustness of the results is limited due to the use of cross-sectional study designs and the use of self-reports on influenza vaccination prevalence. Moreover, many of the studies are based in Western and high-income countries (Schmid et al., 2017). Thus the sociodemographic profile of the participants differs from those in Asian and low- or middle-income countries. Hence, the effect of sociodemographic characteristics on vaccination uptake should be explored further in Malaysia, a Southeast Asian, middle-income country.

Table 2.2 provides a summary of the sociodemographic characteristics that are associated with influenza vaccination.

Table 2.2: Table of Evidence Association between Sociodemographic and Influenza Vaccination Uptake

Author (year)	Country	Study design	Study participants	Findings
Vasilevska et al. (2014)	NA	Systematic review and meta-analysis	37 articles on HCW were reviewed	• Working as a nurse were less likely to get vaccination (pooled OR 0.66; 95% CI 0.46, 0.97)
Schmid et al. (2017)	NA	Systematic review	117 articles on HCW were reviewed	• Higher age and being a female reported as barriers for influenza vaccination
Clark et al. (2009)	USA	Cross sectional	1310 nurses	• Increasing age ($p < 0.001$) • Present of chronic condition considered at high risk for influenza-related complications ($p < 0.001$)
Shahrabani et al. (2009)	Israel	Cross sectional	299 nurses	• Unmarried nurses are less likely to have an influenza vaccination in comparison to married nurses ($p = 0.034$)
Barbadoro et al. (2013)	Italy	Cross sectional	5336 HCW	• Older workers (OR 6.07; 95% CI 4.72, 7.79) • Higher education is associated with lower vaccination uptake (OR 0.65, 95% CI 0.50,0.83) • Smokers have an influenza vaccination more frequently (OR 1.40, 95% CI 1.15, 1.70) • Former smokers also have an influenza vaccination more frequently (OR 1.54, 95% CI 1.24, 1.91) • Those suffering from diabetes (OR 2.07; 95% CI 1.19,1.69), COPD (OR 1.95; 95% C1 1.31,2.89) and cardiovascular diseases (OR 1.48; 95% CI 1.11,1.96) were more likely to be vaccinated

NA: not applicable

"Continued"

Table 2.2: Table of Evidence Association between Sociodemographic and Influenza Vaccination Uptake

Author (year)	Country	Study design	Study participants	Findings
Mytton et al. (2013)	United Kingdom	Cross sectional	998 HCW	• Age more than 40 years (OR 1.78, CI 1.20, 2.64) compare to age less than 39 years. • Nurses or midwives (OR 0.38, CI 0.17, 0.80), other qualified and technical staff (OR 0.30, CI 0.12–0.72) and clinical support staff (OR 0.42, CI 0.18, 0.94) compare to doctors.
Wada & Smith (2013)	Japan	Cross sectional	3,129 Japanese working-aged 20 to 69 years	• The number of children per household: One compared with none (OR 1.37, 95% CI 1.11, 1.65) and more than two compared with none (OR 1.21, 95% CI 0.96–1.50) • Household income per year: $50,000 -$100,000 compared with $0-$50,000 (OR 1.30, 95% CI 1.07, 1.54) • Current smoker (OR 0.79, 95% CI 0.61, 0.98)
Tuckerman et al. (2015)	Australia	Cross sectional	92 HCW	• Younger age (p <0.001) • English as first language (OR 5.29, CI 1.90, 14.71)
Zetti Zainol Rashid et al. (2015)	Malaysia	Cross sectional	211 HCW	• Age (OR 12.4, 95% CI 6.2, 24.8) • Previous vaccination (OR 1.04, 95% CI 1.001, 1.077)
Dorribo et al. (2015)	Switzerland	Cohort	472 HCW	• Being a physician (OR 7.7; 95% CI 3.1–19.1) • Living with a pregnant woman or with an infant (OR 5.83; 95% CI 2.30, 14.80)

"Continued"

Table 2.2: Table of Evidence Association between Sociodemographic and Influenza Vaccination Uptake

Author (year)	Country	Study design	Study participants	Findings
Asma et al. (2016)	Turkey	Cross sectional	642 HCW	• Increasing age ($p < 0.001$). • Male ($p = 0.025$), chronic disease (OR 5.13) • Physician ($p = 0.0004$), working in an internal medicine department ($p < 0.05$) • Living with a person over 65 years ($p = 0.004$).
P. Lu et al. (2016)	USA	Cross sectional	Data from the 2013 and 2014 National Health Interview Survey were analyzed	• Age 50-64 (OR 1.14; 95% CI 1.04-1.26), age > 65 year (OR 1.18; 95% CI 1.04, 1.34) compare to age 18-49 year • Background education of colleague graduate (OR 1.27; 95% CI 1.11, 1.46) • Never been married (OR 0.82; 95% CI 0.73, 0.93)
Hulo et al. (2017)	France	Cross sectional	334 HCW	• Age >40 years (OR 1.93; 95% CI 1.02, 3.67) • Physician vs. the other workers (OR 5.68; 95% CI 2.81,11.49)
Cheung et al. (2017)	Hong Kong	Cross sectional	902 nursing student	• Odds of having a seasonal influenza vaccination is four times higher for nursing students studying on master's programme compared to those studying on the higher diploma (OR 4.01, 95% CI 1.09, 14.73)
Hussain et al. (2018)	Canada	Cross sectional	896 HCW	• Support staff (OR 1.79, 95% CI 1.32, 2.42) and physician (OR 4.24; 95% CI 1.36, 13.2) compare to nurse • Black (OR 0.44; 95% CI 0.26- 0.75) compare to European

"Continued"

Table 2.2: Table of Evidence Association between Sociodemographic and Influenza Vaccination Uptake

Author (year)	Country	Study design	Study participants	Findings
Kyaw et al. (2018)	Singapore	Cross sectional	3873 HCW	• Increasing age (OR 1.04; 95% CI 1.02, 1.05) • Education level of bachelor degree or higher (OR 1.25; 95% CI 1.02, 1.54) • Being a medical staff member (OR 0.36, 95% CI 0.26, 0.51) • Being an allied health staff member (OR 0.58; 95% CI 0.45, 0.76) • Living with family members under the age of 16 years (OR 0.69; 95% CI 0.56, 0.86)
Alshammari et al. (2019)	Saudi Arabia	Cross sectional	364 HCW	• Male (OR 1.40; 95% CI 0.784, 2.51) • Nurse (OR 1.461; 95% CI 0.659, 3.24) compare to physician

2.9.2 The association between knowledge and influenza vaccination

Several studies have shown that vaccinated HCWs have a higher level of knowledge regarding the influenza virus and the vaccination than their non-vaccinated counterparts (Clark et al., 2009; Hulo et al., 2017; Ko et al., 2017; Shahrabani, Benzion, & Yom Din, 2009; Zhang, While, & Norman, 2011). A web-based survey among 242 family medicine residents in Korea found that correct knowledge on the recommended vaccine led to a higher vaccination rate (OR 4.20; 95% CI 1.33, 14.30) (Ko et al., 2017). Also, a study in France showed that being vaccinated is significantly related to a higher knowledge score on items about the epidemiology of influenza (OR 1.63; CI 1.08, 2.46) (Hulo et al., 2017). Furthermore, a research study in the United Kingdom reported that nurses with a high level of influenza knowledge are significantly more likely to be vaccinated for influenza in the previous year ($p < 0.001$) (Zhang et al., 2011). However, in Malaysia, Wong et al found that primary care physicians in the public sector have moderate knowledge of influenza vaccinations (Wong, Muthupalaniappen, & Tie, 2017).

The association between knowledge and vaccination seems well established. However, some misconceptions about the vaccination continue to exist among HCWs. For example, Malaysian HCWs reported good knowledge about the transmission and signs and symptoms of influenza virus, but there was a misunderstanding that the vaccine can cause influenza (34%) (Hudu et al., 2016). It has also been reported that unvaccinated nurses are more likely to agree that the vaccine gives some people influenza ($p = 0.002$), the vaccination is unsafe ($p = 0.002$), and the vaccine may cause serious adverse effects ($p = 0.019$) (Zhang et al., 2011).

In summary, previous studies have established that there is an association between knowledge and influenza vaccination. Nevertheless, some misconceptions persist, and these need to be explored further because a knowledge deficit regarding the in issue could have negative implications for uptake.

Table 2.3 summarizes the evidence that has been reported on the association between knowledge and influenza vaccination.

Table 2.3: Table of Evidence Association between Knowledge and Influenza Vaccination Uptake

Author (Year)	Country	Study design	Study participants	Findings
Shahrabani et al. (2009)	Israel	Cross sectional	299 nursing students	Nurses who are vaccinated have higher levels of knowledge regarding the vaccine and influenza virus (p<0.001)
Zhang et al. (2011)	United Kingdom	Cross sectional	522 nurses	Nurses with a high knowledge level were more likely to get vaccinated compared to those with a low knowledge level (p < 0.001). Poor knowledge about some items among unvaccinated nurses were more likely to agree that: ''Vaccination may have serious adverse effects'', ''Vaccinations give some people influenza'' and ''Seasonal influenza vaccines are unsafe'' (p <0.005)
Atladóttir. (2014)	Sweden	Cross sectional	175 emergency worker	There was a significant difference in mean knowledge score between those who had been vaccinated in the last 12 months (mean 17.9 ± 2.7) and those who had not been vaccinated (mean 16.8 ± 2.6) (P< 0.05)
Hudu et al. (2016)	Malaysia	Cross sectional	527 HCWs	Malaysian HCWs reported good knowledge about the signs and symptoms and transmission of influenza virus, but 34% has misunderstanding that the vaccine can cause influenza
Wong et al. (2017)	Malaysia	Cross sectional	108 primary care physicians	Primary care physicians in the public sector have moderate knowledge of influenza vaccinations (descriptive study)
Hulo et al. (2017)	France	Cross sectional	344 HCWs	Being vaccinated was significantly related to a higher knowledge score based on epidemiological influenza items (OR 1.63; 95% CI 1.08–2.46) and vaccine features items (OR 2.36; 95% CI 1.36,4.10)
Ko et al. (2017)	South Korea	Cross sectional	242 HCWs	Participants with correct knowledge on the recommended vaccine had a higher vaccination rate than those who had incorrect knowledge on influenza (OR 4.20; 95% CI 1.33,14.30)

2.9.3 The association between behavioural determinants and influenza vaccination

2.9.3.1 Perceived susceptibility

Perceived susceptibility is an essential factor that needs to be explored because an individual's perception that they are at low risk of contracting the infection leads to vaccination non-compliance. As evidenced in prior research, a lack of personal susceptibility to influenza constituted the main deterrents of influenza vaccination among nurses in France (Wilson et al., 2019). Moreover, a study among family medicine residents in South Korea also cited the most common reason for not having a vaccination is the perceived low possibility of contracting the infection (35.4%) (Ko et al., 2017).

Those HCWs who perceive that they do have a higher susceptibility of influenza infection are more likely to get the vaccination (Cheung et al., 2017; Johansen, Stenvig, & Wey, 2012; Lehmann, Ruiter, van Dam, Wicker, & Kok, 2015; Shahrabani et al., 2009; Tuckerman et al., 2015). For example, in Hong Kong, it has been reported that nursing student who perceives that they have a susceptibility to influenza infection are more likely to get vaccinated (OR 2.76; 95% CI 1.62, 4.69) (Cheung et al., 2017). Similarly, HCWs in Dutch, Belgian and German with a high perceived susceptibility to contracting influenza have been shown to have a high intention to receive the influenza vaccination (Lehmann et al., 2015).

In a Malaysia-based study on HCWs, it was reported that 70.8% of the participants mentioned that the reason for having a vaccination was the belief they are at risk of contracting the influenza infection (Zetti Zainol Rashid et al., 2016). Similarly, another study conducted among HCWs in Malaysia reported that 84.1% of the participants agreed that they are at risk of getting influenza (Hudu et al., 2016). However, the association was not significant. Therefore, due to the non-significance of this finding, there is a need to further explore the relationship between perceived susceptibility and influenza vaccination uptake in Malaysia.

2.9.3.2 Perceived severity

Many studies have reported that HCWs who perceive that influenza is a serious disease are more likely to get vaccinated against it (Shahrabani et al., 2009, Tuckerman et al., 2015, Cheung et al., 2017, Alenazi et al., 2018). For example, a study among Saudi Arabia HCWs found that those who have an awareness that influenza is dangerous for them are more likely to get vaccinated (Alenazi et al., 2018). Moreover, an additional predictor for influenza vaccination uptake among HCWs is their awareness that the disease is dangerous for patients (Tuckerman et al., 2015).

However, there is a lack of awareness among HCWs that influenza can affect their family members as well. Alenazi et al. (2018) reported the need to protect family members had a lesser effect on compliance to vaccination than their individual preference for self-protection from the influenza infection. Given this finding, there is a need to further investigate the factor of perceived severity in the Malaysian setting.

2.9.3.3 Perceived benefits

The decision to have the influenza vaccination is also determined by the belief that doing so results in the benefit of reducing the disease threat. Thus a low perceived benefit may lead to non-compliance and low vaccination uptake. Perceived benefit has commonly been reported as a predictor of vaccination uptake in previous studies (Asma et al., 2016; Hakim et al., 2011; Jaiyeoba, Villers, Soper, Korte, & Salgado, 2014; Mytton et al., 2013; H. Seale et al., 2010; Shahrabani et al., 2009). The benefits of having the vaccination include reducing the personal risk of the HCW and reducing the risk of spreading the infection to patients and family members.

For example, a study found a difference between the vaccinated and non-vaccinated group regarding perceived benefits ($p = 0.021$), where the former group believe that the influenza vaccination will prevent them from getting the illness (Shahrabani et al., 2009). It has also been reported that vaccinated HCWs hold the belief that vaccination is essential in protecting patients or family members (H. Seale et al., 2010). Furthermore, another study found significant differences between vaccination-compliant and non-compliant groups for the expected benefit from vaccination (Asma et al., 2016). Specifically, the vaccination-compliant HCWs were more likely to perceive the advantage of influenza vaccination in reducing personal risk (OR 30.2; 95% CI 4.1, 219.9), the risk for patients (OR 13.4; 95% CI 3.2, 55.4) and for family members (OR 9.3; 95% CI 2.9, 30.2) ($p < 0.001$) (Asma et al, 2016).

However, perceived benefits were not found to be a significant predictor in the study conducted in Hong Kong by Cheung et al. (2017). Their non-significant result could be due to inadequate knowledge in this area among the nursing students who made up the study sample. Given that there is some lack of consistency in the literature in the Asia region, there is a need to investigate the beliefs held by HCWs in Malaysia about the benefits of the influenza vaccination.

2.9.3.4 Barriers to influenza vaccination

Several studies have documented a wide range of barriers to influenza vaccination. Barriers to vaccination include doubt in the effectiveness of the vaccination, belief in alternative medicine, fear of injection, personal belief and yearly vaccination (Asma et al., 2016; Petek & Kamnik-Jug, 2018; Shahrabani et al., 2009). However, one of the most frequently cited barriers is the fear of side effects or adverse reactions to the vaccination (Asma et al., 2016; Clark et al., 2009; Norton et al., 2008; Zhang et al., 2011). For instance, Asma et al. (2016) found that a lower level of perceived barriers is associated with higher vaccination compliance. The study showed that 51.8% of the vaccination-compliant participants do not expect side effects after vaccination ($p = 0.004$). It also showed that 73.7% of the vaccination-compliant think that allergic reactions to influenza are rare or non-existent ($p < 0.001$). Finally, only 36.8% of the vaccination-compliant and 24% of the non-compliant participants reported having ever experienced a side effect from the previous vaccination (Asma et al., 2016).

Even though worrying about side effects is common, reported adverse events are mild or rare. For instance, while approximately 39% of vaccinated respondents in one study complained of at least one post-vaccination symptom (Norton et al., 2008). The study reported that the most common adverse event was arm soreness, where 23% of the respondents complained of arm soreness lasting for more than one day. Norton et al. (2008) also found that the other most commonly reported adverse events were redness, skin swelling, myalgia and fever.

In contrast, a study in Pakistan, a low-income country, revealed that only 11% of the HCWs admitted that they feared the side effects of the influenza vaccination. The rest of the respondents disagreed with the statement that safety concerns and side effects may hinder HCWs' willingness to get the influenza shot (Tahir Mehmood Khan, Khan, Ali, & Wu, 2016)

Due to frequent antigenic drift, the influenza virus keeps evolving and escaping population immunity, so a yearly vaccination is required to combat influenza (Sam, 2015). Some HCWs find the need for frequent vaccination (yearly) acts as a barrier to vaccination compliance. Nevertheless, there is a significant difference between the vaccination-compliant and non-compliant group with regards to the discomfort of an annual regimen. For instance, in Saudi Arabia, it has been found that the vaccination-complaint group does not think that the yearly vaccination is uncomfortable (OR 0.3; 95% CI 0.1, 0.5, p = 0.001) (Alenazi et al, 2018). Similarly, Win et al. (2018) in Singapore found that having knowledge of the need to vaccinate yearly significantly associated with the future plan of influenza vaccination (OR 1.91; 95% CI 1.56, 2.33).

Other commonly cited reasons for refusal to have the vaccination are the time constraint, lack of safety of the vaccination, fear of contracting influenza due to the vaccination and lack of vaccination effectiveness (Hulo et al., 2017; Zetti Zainol Rashid et al., 2015). In addition, in a study in Pakistan, lack of awareness with the usage of vaccination, needle fear and non-compulsory policy are the top three identified barriers to vaccination (Tahir Mehmood Khan et al., 2016).

In short, the barriers to influenza vaccination can be individual, organization or vaccination-related. Due to their variety, which could be context-dependent, the barriers need to be investigated in the Malaysian setting in order to identify which are the most influential in deterring HCWs from having the vaccination.

2.9.3.5 Health motivators for influenza vaccination

Several studies have reported that higher health motivation is associated with higher influenza vaccination uptake (Asma et al., 2016; Cheung et al., 2017; Shahrabani et al., 2009; Zhou et al., 2013). In the case of Israel, it has been reported that nurses who are vaccinated have higher levels of health motivation than those who do not have the vaccination (Shahrabani et al., 2009). Meanwhile, in Turkey it has been found that the health motivators for influenza vaccination uptake are knowing the Ministry of Health recommendation about the influenza vaccination, having sufficient knowledge from reliable sources and a free vaccination policy ($p < 0.05$) (Asma et al., 2016). However, the results of a study conducted in Saudi Arabia contradict those reported for Turkey. Alenazi et al. (2018) found that in the Saudi Arabian context, there is no association between the above motivating factors and influenza vaccination.

However, incentives can play a role in improving vaccination uptake, as shown by Zhou et al. (2013) who found that a subsidy for influenza vaccination for HCW is one of the health motivators for vaccination and that it is significantly associated with vaccination uptake. Besides, the employer offered paid leave or time off work for vaccination is another incentive associated with higher influenza vaccination uptake in a study by Tahir Mehmood Khan et al. (2016)

In light of the above, identifying the health motivators for vaccination uptake is crucial as they could be utilized to good effect in future vaccination campaigns. However, this factor is under-studied in Malaysia and hence requires further exploration.

2.9.3.6 Social influence

According to the results of a study by Corace et al. (2013), the vaccination rate is higher among HCWs who believe that they are more likely to get a vaccination against influenza if their doctor or family member recommends the vaccination. Encouragement in the workplace from colleagues, supervisors and the employing organization itself have also been found to be critical external cues to action or, in other words, to exert social influence on vaccination uptake. For instance, Asma et al. (2016) reported that the vaccination-compliant group in their study are more likely to agree that relatives, workplace, colleagues, health authorities and the Ministry of Health believe that the influenza vaccination is necessary and recommend the vaccination. In contrast, a study by Hakim et al. (2011) reported a low level of influence from external cues, where only 25.6% of the vaccinated HCWs agreed that family, friends and doctors recommended that they get the influenza vaccination. Furthermore, only 34.8% of the vaccinated HCWs agreed with the statement that their employer asked them to have the vaccination (Hakim et al., 2011).

The review of the literature revealed that there are numerous sources of social influence such as family members, work colleagues, supervisors, physicians and health authorities. Also, differences in the sociodemographic background may play a part in the effect of social influence on the decision to have the influenza vaccination. Therefore, this influence needs to be explored in the Malaysian setting so that it can be highlighted and leveraged in future vaccination campaigns.

2.9.3.7 Attitude

K. Corace et al. (2013) reported that, in their study of HCWs in Canada that the respondents believe that all HCWs should be vaccinated against influenza (OR 18.40;

95% CI 13.81, 24.52). The study also showed that non-vaccinated HCWs are more likely to agree that HCWs should be given freedom of choice in deciding to get a vaccination as compared to the vaccinated group (OR 0.18; 95% CI 0.13, 0.27). Regarding the issue of making vaccination mandatory, Hakim et al. (2011) reported that 36.6% of HCWs opposed mandating influenza vaccination. In the study, violation of freedom of choice and personal autonomy are the most frequently reported reasons for opposition to vaccinations. Therefore, the opinions that HCWs hold on mandatory vaccination in Malaysia need to be explored to provide evidence for policy formulation.

2.9.3.8 Self-efficacy

Self-efficacy, in relation to influenza vaccination, has been found to differ between vaccination-compliant and non-compliant groups ($p < 0.005$) in a study by Asma et al. (2016). In the study, participants were self-confident that they would be vaccinated if they had enough time, someone reminded them, vaccination was provided at their workplace, and rewards and sufficient knowledge were given (Asma et al., 2016). As regards the level of confidence among HCWs about having the vaccination, Hussain et al. (2018) reported that there is a statistically significant difference between vaccinated and non-vaccinated HCWs in relation to the statement that they would be vaccinated provided that the vaccination was available ($p = 0.005$).

Although self-efficacy is an essential component in the HBM, it seems that this factor has never been investigated in the Malaysian setting. Thus further exploration is required. Table 2.4 summarizes the associations that have been found between the above-discussed behavioural determinants and influenza vaccination.

Table 2.4: Table of Evidence Association between Behavioral Determinants and Influenza Vaccination Uptake

Behavioral Determinants	**Norton et al. (2008)**	**Shahrabani et al. (2009)**	**Seale et al. (2010)**	**Hakim et al. (2011)**	**Mytton et al. (2013)**	**Zhou et al. (2013)**	**K. Corace et al. (2013)**	**Jaiyeoba et al. (2014)**
Perceived susceptible		X			X		X	
Perceived severity		X					X	
Perceived benefits		X	X	X	X		X	X
Perceived barriers	X	X		X	X		X	
Motivating factors		X		X		X		
Social influence							X	
Attitude							X	
Self-efficacy								

“X” indicates behaviour determinants associated with influenza vaccination

"Continued"

Table 2.4: Table of Evidence Association between Behavioral Determinants and Influenza Vaccination Uptake

Behavioral Determinants	**Lehmann et al. (2015)**	**Tuckerman et al. (2015)**	**Asma et al. (2016)**	**Cheung et al. (2017)**	**Ko et al. (2017)**	**Alenazi et al. (2018)**	**Petek & Kamnik-jug (2018)**	**Wilson et al. (2019)**
Perceived susceptible	X		X	X	X			X
Perceived severity				X		X		
Perceived benefits		X	X					
Perceived barriers			X	X			X	
Motivating factors			X					
Social influence			X					
Attitude			X			X		
Self-efficacy			X			X		

"X" indicates behaviour determinants associated with influenza vaccination

2.9.4 The association between health literacy and influenza vaccination

2.9.4.1 Concept of health literacy

The concept of HL is based on a person's knowledge, motivation and competencies in how to access, understand, appraise, and apply health information. Having HL enables the individual to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life or health outcome (World Health Organization, 2013b). Figure 2.2 illustrates the integrated model for HL.

The model can be exemplified as follows: Consider a 25-year-old (age), Malay (race) female (gender) who has a diploma in nursing (education) working as a staff nurse (occupation) earning a salary of 2500 Malaysian ringgit (RM) per month (income). She learns about the influenza vaccination in a continuous nursing education seminar (ability to access). During the seminar, she is given a pamphlet regarding influenza infection. She reads the information in the pamphlet about the potential risk of the vaccine (ability to read, understand) and decides that the benefit of the vaccination outweighs the risk of the vaccination (ability to appraise) and finally decides to get vaccinated (ability to apply). By taking this action, she reduces influenza-related work absenteeism (health outcome).

In contrast to the above general definition of HL by WHO, Nutbeam classified HL into three levels: functional HL, communicative HL and critical HL (Nutbeam, 2000). Functional HL is a basic reading and writing skills of a person to be able to function in daily routine. Communicative HL is the ability to extract and communicate information and apply the new knowledge to different situations. Meanwhile, critical HL is a more advanced cognitive skill that can be applied to critically analysed the information and used it to make decisions.

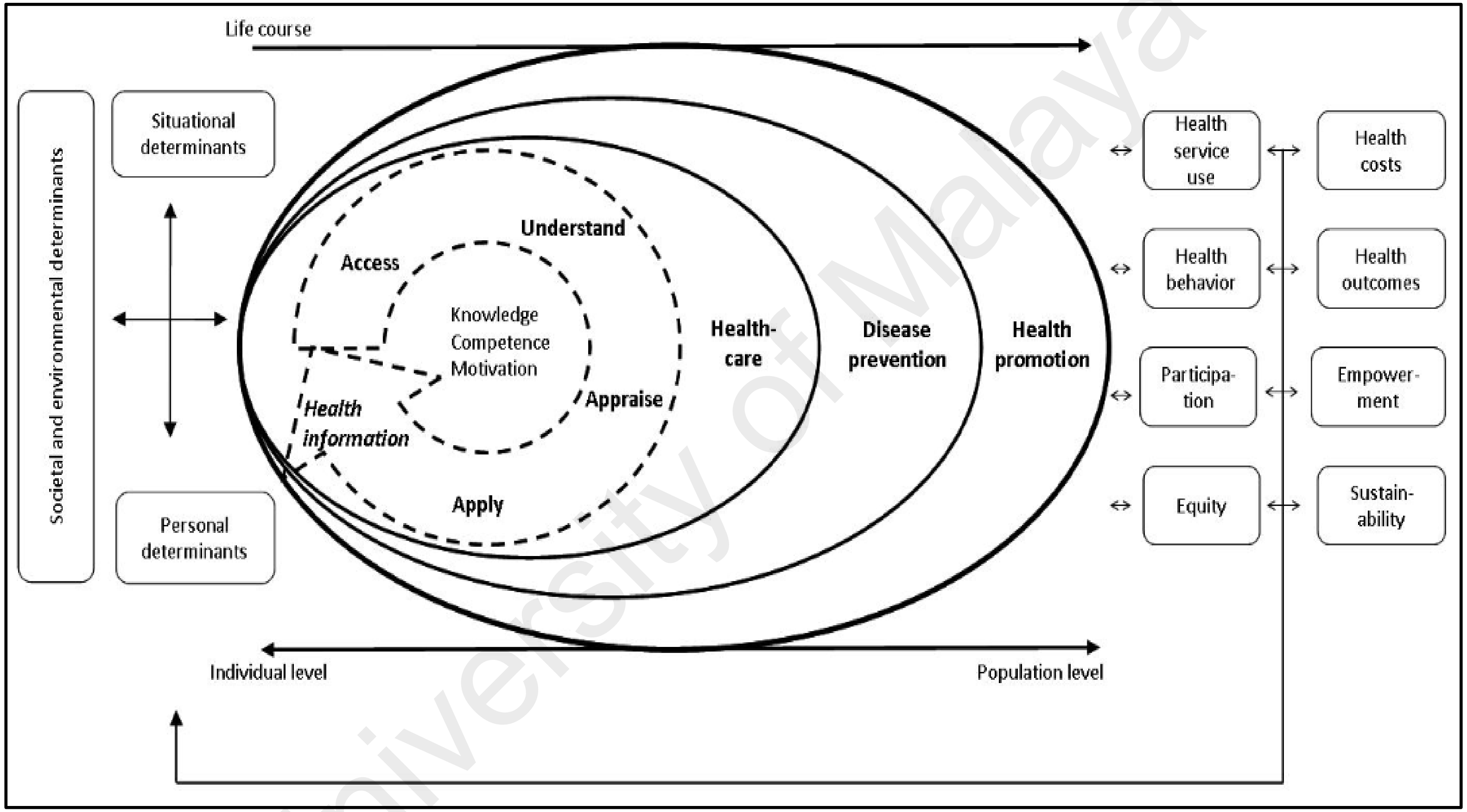

Figure 2.2: Integrated model for health literacy
Source: Sørensen et al. (2012)

2.9.4.2 Prevalence of health literacy

Sørensen et al. (2015) measured general HL in eight countries in Europe by using the European Health Literacy Survey (HLS-EU). They found that 1 in 10 Europeans have inadequate HL (Sørensen et al., 2015). Moreover, data from the USA shows that one-third of English speakers have inadequate or marginally functional HL (Scott, Gazmararian, Williams, & Baker, 2002). Similarly, a study among multi-ethnic groups of women in Taiwan using the Taiwan Health Literacy Questionnaire showed that one-third of the participants have inadequate HL (Tsai, Cheng, Chang, Yang, & Wang, 2014).

In Malaysia, My Body is Fat and Fabulous at Home (MyBFF@home) is a 12-month community-based obesity intervention study that was recently conducted among overweight or obese housewives who lived in low-cost flats in Kuala Lumpur (Siew et al., 2018). The researchers used the Newest Vital Sign (NVS) tool (Pfizer, n.d.) to measure the participants' level of HL and found that only 10% of them have adequate HL, 70% have limited HL, and 20% have possible limited HL (Siew et al., 2018).

A few years earlier, in 2015, the National Health and Morbidity Survey (NHMS) measured the level of HL among the Malaysian population using the NVS tool for the first time. The results of the study showed that the prevalence of adequate HL among adults aged more than 18 years old is 6.6% (Institute for Public Health, 2015a). The study also showed that there is an obvious difference between the level of adequate HL among the urban and rural population (7.8% vs 2.3%). Also, Chinese reported the highest prevalence of adequate HL [10.6% (95% CI 8.2, 13.6)], followed by Indians [10.1% (95% CI 7.0, 14.6)] and Malays [6.0% (95% CI 4.8, 7.4)]. The prevalence of adequate HL was found to be highest among the age group of 20–34 years old. Adults with tertiary education [11.0% (95% CI 9.3, 13.0)] were found to be more adequate in HL than those with a primary [2.4% (95% CI 1.5, 3.6)] or secondary education [5.1% (95% CI 4.1, 6.5)]. As for the association with the occupational sector, government/semi-government employees [8.5% (95% CI 6.6, 10.8)] had the highest prevalence of adequate HL.

The prevalence and level of HL, specifically among HCWs in Malaysia, is as yet unknown. Hence, it is vital to investigate the level of HL among this group and estimate the consequence of limited HL from an occupational perspective. However, based on these NHMS 2015 findings, we hypothesize that the HCWs in the current study will have high HL because they are government servants from urban areas and have a tertiary level of education.

2.9.4.3 Measurement tools for health literacy related to vaccination

As discussed above, two tools include NVS and HLS-EU have been used to measure general HL. According to Health Literacy Tool Shed, which is a database of health literacy measure, there are more than 100 tools available to measure general HL ("Health Literacy Tool Shed," 2019). However, a HL instrument has not yet been developed to specifically measure vaccine literacy. Thus, health literacy specific to vaccination is not well measured, especially among HCWs.

From the literature review, a few approaches have been adopted and/or adapted to measure HL related to vaccination. These include Chew's Set of Brief Screening Questions (SBSQ) (Chew et al., 2008), the National Assessment of Adult Literacy (NAAL) (Kutner et al., 2006), the Test of Functional Health Literacy in Adults (TOFHLA) (Parker et al, 1995) and the NVS tool (Pfizer, n.d.). However, most existing HL instruments mainly focus on reading comprehension (functional HL). Hence, researchers have called for the development of new tools to address a broader dimension of HL, including not only functional HL, but also communicative HL and critical HL (Kiechle, Bailey, Hedlund, Viera, & Sheridan, 2015; McCormack, Haun, Sørensen, & Valerio, 2013).

One of the studies that have investigated the relationship between the above-mentioned three dimensions HL is the study by Aharon, Nehama, Rishpon, & Baron-Epel who examined the relationship between parental HL and decision making related to child vaccinations (Aharon, Nehama, Rishpon, & Baron-Epel, 2016). In their study, HL was measured by adapting and using a Health Literacy Questionnaire that was initially developed by Ishikawa, Takeuchi and Yano (2008) to assess functional, communicative and critical HL among diabetic patients. Aharon et al. (2016) adapted the questionnaire to measure vaccine literacy regarding the topic of childhood vaccination. However, they do not describe the psychometric properties of the adapted questionnaire, only the Cronbach's alpha results, which are 0.70 for functional, 0.66 for communicative and 0.81 for critical HL. For this reason, studies that focus on analysing the psychometric properties of a specific measure of vaccine literacy are still needed.

2.9.4.4 Association between health literacy and influenza vaccination uptake

Lorini et al undertook a systematic review of nine studies to comprehend the role of HL as a determinant of vaccine hesitancy (Lorini et al., 2018). The study found a few key factors such as country, age, and type of vaccine predicting vaccine acceptance. However, the researchers concluded that the relationship between HL and vaccination remains unclear (Lorini et al., 2018).

Among the few studies that have been undertaken in the area of vaccine literacy generally is the study by Aharon et al. (2016). Their cross-sectional study is relatively unusual as it measured functional, communicative, and critical HL, not just general HL, among 731 parents of children aged 3–4 years old in Israel. They measured compliance with the recommended childhood vaccination protocol and found that parents with highly functional, communicative, and critical HL are more at risk of not vaccinating their children (Aharon et al., 2016). Similarly, a cross-sectional study by Castro-Sánchez, Vila-Candel, Soriano-Vidal, Navarro-Illana, & Díez-Domingo measured the influence of HL on uptake of influenza and pertussis vaccinations among Spanish pregnant women (Castro-Sánchez, Vila-Candel, Soriano-Vidal, Navarro-Illana, & Díez-Domingo, 2018). The study found women with a higher level of HL measured by Short Assessment of Health Literacy for Spanish Adults (SAHLSA) (S.-Y. D. Lee, Stucky, Lee, Rozier, & Bender, 2010) associated with lower influenza vaccination uptake.

Another measure, Chew's SBSQs, has also been used to determine the relationship between the HL level and vaccination uptake. A cross-sectional study conducted among 467 Dutch parents of newborns aged six weeks used Chew's SBSQs to measure the HL level (Veldwijk et al., 2015). The study found that parents with lower functional HL demonstrate more interest in the duration of vaccine protection rather than in the effectiveness of the vaccination and the frequency of severe side effects (Veldwijk et al., 2015).

The S-TOFHLA questionnaire has also been used in research on vaccination uptake, specifically immunization. Pati et al. (2011) performed a cohort study among 506 Medicaid-eligible mother-infant dyads in the USA to measure HL and its relationship with early infant immunization. The study results revealed that maternal HL is not associated with early infant immunization status at 3 months (OR 1.08; 95% CI 0.67, 1.76, $p = 0.76$) or at 7 months (OR 0.92; 95% CI 0.57,1.48, $p = 0.74$) (Pati et al., 2011).

The above finding is in contrast to that reported by Johri et al. (2015), who conducted a cross-sectional study in India among 1170 women from 60 villages (rural) and 670 women from nine slum clusters (urban). In their research, the measurement of HL was based on Indian child health promotion materials and the outcome of the diphtheria-tetanus-pertussis vaccination for children (Johri et al., 2015). The study found that maternal HL was independently associated with child vaccination.

White et al. in their cross-sectional study among 18,000 adults aged 16 and older in the USA found that adult HL has a positive association with the receiving of the influenza vaccination in the elderly (White, Chen, & Atchison, 2008). Conversely, the study showed that there is a negative relationship between HL and the influenza vaccination among adults who are younger than 40 years old.

Another study undertaken in the USA attempted to identify the association between HL and the use of preventive services such as influenza and pneumococcal vaccinations (Scott et al., 2002). The study was conducted among 2,700 older adults and found that participants with a low HL are much more likely to have never received an influenza vaccination (29% vs 19% in those with adequate HL; $p = 0.0001$). Similarly, a USA-based study of 2,512 older people that assessed HL using the rapid estimate of adult literacy in medicine tool (REALM) (Davis et al., 1993) found that participants in the lower HL categories are less likely to have received an influenza vaccination in the previous 12 months (Sudore et al., 2006). In a similar vein, Lee at al. conducted a cross-sectional study among 2,270 college-aged women and reported positive associations between HPV awareness and knowledge and the completion of human papillomavirus (HPV) vaccinations (H. Y. Lee et al., 2015).

In summary, from the literature review, we found that most studies reported an association between HL and infection prevention-related behaviour. However, most of these studies were conducted in high-income countries such as the USA. Therefore, the transferability of the data to low- or middle-income countries is not guaranteed. Moreover, most of the studies focused on functional HL. However, recently, many researchers have suggested that the broader dimension of HL (including communicative and critical HL not just functional HL) needs to be investigated. This broader dimension of HL is yet to be explored in this study.

In addition, previous studies mainly concentrated on specific populations, such as the elderly and parents. There is a distinct lack of research into the HL of the HCW group. Although reliable health information is easily available to most HCWs, it should not be assumed that access to such information automatically leads to an informed and involved HCW. There are one or two papers that state that they are investigating HL and their titles reflect this, but the studies reported in those papers actually measure knowledge about a disease or awareness about a disease (Tahir M Khan, Sulaiman, & Hassali, 2010; H. Y. Lee et al., 2015).

In light of the above, and also due to the fact that there is a lack of a standardized evaluation tool for vaccine literacy, it is necessary to develop and validate a health literacy questionnaire specific to influenza vaccination that covers all the relevant HL dimensions. Table 2.5 provides the details of studies that have been published on the association between HL and vaccination uptake to date.

Table 2.5: Table of Evidence Association between Health Literacy and Vaccination Uptake

Author	Country	Study design	Study participants	Measure of HL	Outcome	Findings
Lorini et al. (2018)	NA	Systematic review	Inclusion criteria: 1. Primary studies that investigate the link between HL and behaviour towards all kinds of vaccination among persons of all ages 2. HL has been measured using a tool that investigated one or more HL areas, such as basic or functional literacy, communicative or interactive literacy, and critical literacy 3. Published from 1 January 2007 to 15 January 2017			Only nine studies fulfilled the inclusion criteria. The types of outcome measured varied such as influenza, human papillomavirus (HPV), and pneumococcal vaccines and childhood immunization (e.g. Hepatitis B, diphtheria-tetanus-pertussis, mumps, measles, rubella, polio, Haemophilus influenza Type B, pneumococcal, and rotavirus vaccinations). The approach for measuring HL varied among different studies such as NAAL, S-TOFHLA, NVS, and SBSQ. Some HL-specific questionnaires are also adapted to measure the HL. The relationship between HL and vaccinations remains unclear.
Pati et al. (2011)	USA	Longitudinal prospective cohort study	506 Medicaid-eligible mother-infant dyads	S-TOFHLA	Immunization status at age 3 and 7 months	Maternal health literacy is not associated with infant immunization status at 3 months (OR 1.08; 95% CI 0.67,1.76, p value 0.76) and at 7 months (OR 0.92; 95% CI 0.57, 1.48, p =0.74)
Sudore et al. (2006)	USA	Cross sectional	2,512 older people	REALM	Influenza vaccination uptake	Participants in the lower HL categories are less likely to have received an influenza vaccination in the previous 12 months (OR 1.70; 95% CI 1.20, 2.41)

“Continued”

Table 2.5: Table of Evidence Association between Health Literacy and Vaccination Uptake

Author	Country	Study design	Study participants	Measure of HL	Outcome	Findings
White et al. (2008)	USA	Cross sectional	18,000 US adults aged 16 and older	NAAL	Flu shot	A negative relationship between HL and the influenza vaccination was demonstrated for adults younger than 40 years (β -0.07, SE 0.02).
Scott et al. (2002)	USA	Cross sectional	2,700 older adults	S-TOFHLA	Uptake of influenza and pneumococcal vaccinations	Participants with a low HL are much more likely to have never received an influenza vaccination (29% vs 19% in those with adequate HL; p = 0.0001).
Veldwijk et al. (2015)	Netherland	Cross sectional	467 Dutch parents of newborns aged 6 weeks	Chew’s SBSQ	Parental preferences for rotavirus vaccination	Parents with higher health literacy may be less likely to vaccinate their newborn against rotavirus than parents with lower health literacy
Johri et al. (2015)	India	Cross sectional	1170 women from 60 villages (rural) and 670 women from nine slum clusters (urban)	Indian child health promotion materials	Diphtheria–tetanus–pertussis vaccination for children.	Urban: high HL was associated with DTP3 vaccination (OR 1.98 95%; CI 1.03 to 3.80, p<0.040) as compared with mothers with low HL. Rural: medium HL was associated with DTP3 vaccination (OR 1.62; 95% CI 1.15, 2.30, p=0.006)
H.Y. Lee et al. (2015)	USA	Cross sectional	2,270 college-aged women	5 items about HPV virus and HPV vaccination	HPV Vaccination	Positive associations with the completion of HPV vaccinations, and with HPV literacy (OR 2.26, p< .001)

“Continued”

Table 2.5: Table of Evidence Association between Health Literacy and Vaccination Uptake

Author	Country	Study design	Study participants	Measure of HL	Outcome	Findings
Aharon et al. (2017)	Saudi Arabia	Cross sectional	731 parents of children aged 3–4 years	Functional, communicative, and critical health HL	Compliance with a recommended childhood vaccination protocol	Parents with higher communicative HL were more likely to not vaccinating their children (β -0.06, p-value <0.05)
Castro-Sánchez et al. (2018)	Spain	Cross sectional	119 pregnant women	SAHLSA	Influenza and pertussis vaccination uptake	Women with a higher level of functional HL associated with lower influenza vaccination uptake.

NA: Not applicable
Chew’s SBSQ: Chew’s set of brief screening questions
S-TOFHLA: Short form test of functional health literacy in adults
NAAL: National assessment of adult literacy
NVS: Newest vital sign
REALM: Rapid estimate of adult literacy in medicine tool
SAHLSA: Short assessment of health literacy for Spanish adults

2.10 Effectiveness of influenza vaccination

Several measures for investigating the effectiveness of the influenza vaccination have been studied from three different perspectives. The perspectives are the occupational health, employer and patient safety perspective (Kliner et al., 2016; Ng & Lai, 2011; Restivo et al., 2018; Abu H Samad et al., 2006). The measures include laboratory-confirmed influenza and clinically suspected influenza (the occupational health perspective), working days lost and sickness presenteeism (the employer perspective) and laboratory-confirmed influenza, clinically suspected influenza, hospitalization or death of patients (patient safety perspective). Figure 2.3 summarizes the perspectives and measures of the effectiveness of influenza vaccination among HCWs.

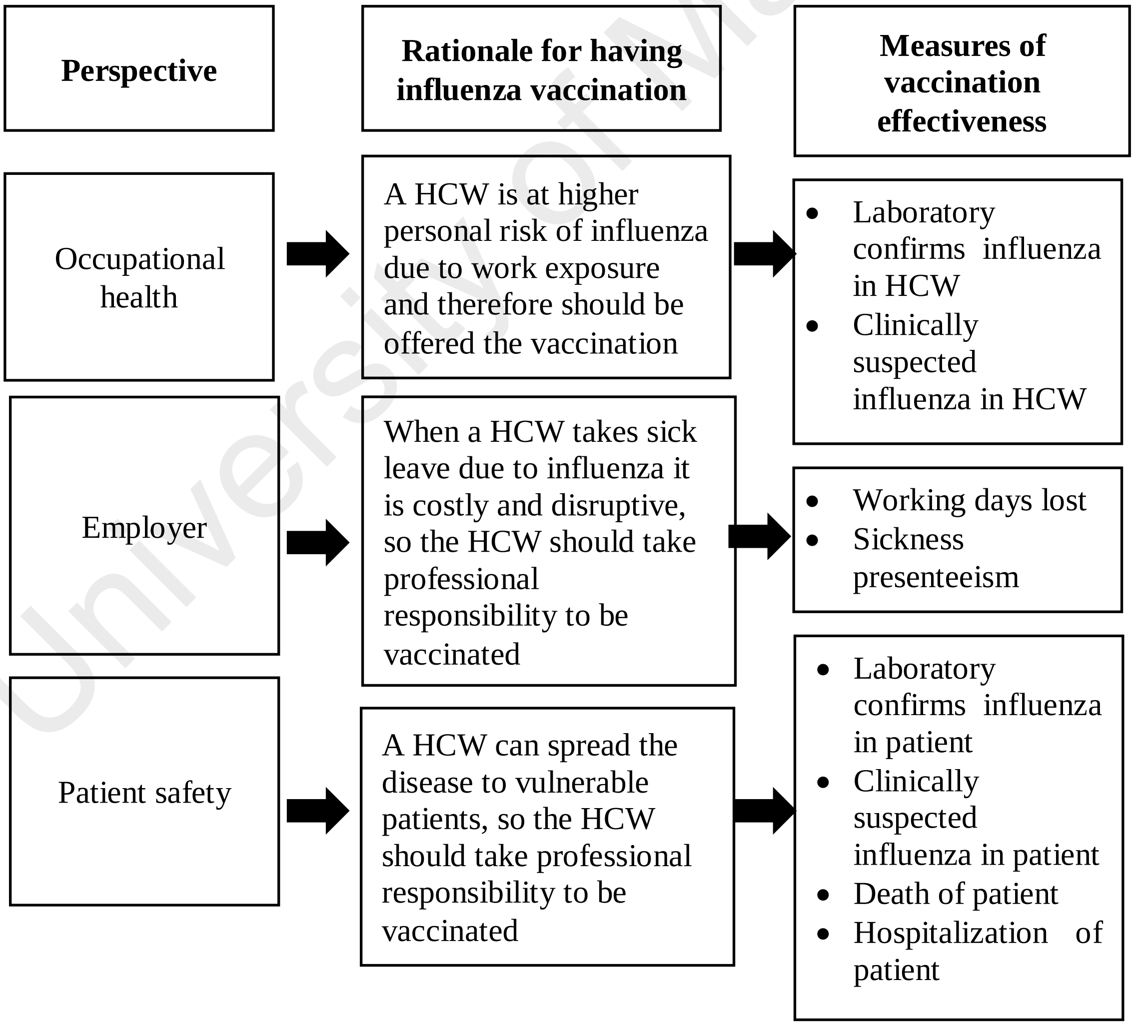

Figure 2.3: Perspectives and measures of the effectiveness of influenza vaccination
Source: Adapted from Kliner et al. (2016)

Wilde et al. (1999) performed a randomized control trial among 264 HCWs to investigate the effectiveness of trivalent influenza vaccination in reducing infection, illness, and absence from work in young, healthy healthcare professionals. The study found a vaccine efficacy of 88% for influenza A and 89% for influenza B. The study also reported a decrease in the cumulative workdays lost in the vaccinated group as compared to the non-vaccinated group (9.9 per 100 subjects vs 21.1 per 100 subjects, respectively). However, the result is not statistically significant ($p = 0.4$).

Similarly, Ferroni and Jefferson. reported a reduction in the mean difference of workdays lost if the vaccine was well matched to the circulating virus (mean difference workdays lost: good match is 0.21 vs absent match/unknown is 0.09) (Ferroni & Jefferson, 2011). The researchers concluded that the influenza vaccine might be marginally more effective than a placebo at reducing time off work in healthy people aged 14 to 60 years. Kuster et al. conducted a systematic review and meta-analysis of 29 published studies involving 97 influenza seasons. The analysis included 58,245 HCWs and healthy adults and found that influenza vaccination is effective in protecting HCWs and in reducing infections in both symptomatic and asymptomatic individuals (Kuster et al., 2011).

Similarly, Ng and Lai (2011) performed a systematic review and meta-analysis of three published studies to evaluate the effectiveness of influenza vaccinations in preventing ILI, laboratory-confirmed influenza infections and reducing working days lost among HCWs. The researchers found vaccination effectiveness of 88% against laboratory-confirmed influenza cases. However, the limited number of studies included in the analysis did not allow the researchers to make a definitive conclusion about the overall impact of the influenza vaccination on HCWs themselves in terms of a reduction of ILI, the number of days with ILI symptoms and the amount of sick leave (Ng & Lai, 2011).

The more recent study by Zaffina et al among HCWs in paediatric hospital in Italy found that absenteeism is significantly higher in unvaccinated HCWs than in vaccinated HCWs (increase of 0.38 in average absenteeism in 2016/17 influenza season and increase of 0.46 in 2017/18 influenza season) (p-value <0.05) (Zaffina et al., 2019). Furthermore, the study reported the total days lost in unvaccinated people are about 740 per year.

Besides work absenteeism, previous studies also looked at sickness presenteeism or attendance of HCW at work during sickness. This is particularly important as their presence can increase workplace influenza transmission and reduce work efficiency. Many HCW report having worked while febrile or with ILI symptoms. Imai et al reported 14% of HCW were working while ill with influenza (Imai, Hall, Lambert, Katharina, & Merollini, 2019). A systematic review included 24 studies reported the prevalence of sickness presenteeism among HCW was high, ranged from 35-97% (Webster et al., 2019). Samad et al. (2006) in their study among petrochemical worker in Malaysia reported another benefit of influenza vaccination is in reducing sickness presenteeism and it is cost saving.

In summary, only a few studies have been conducted on influenza vaccination effectiveness among HCWs, especially in tropical countries such as Malaysia. One of the main concerns that need to be borne in mind when looking at the issue of vaccination effectiveness is the waning of immunity because this results in a decrease in the vaccination benefit (Ferdinands et al., 2017). This is an issue of particular importance as the influenza season continues throughout the year in tropical countries. In addition, the previous literature has mainly examined the effectiveness of influenza vaccination among non-HCW. Also, the measures that have been used to assess the effectiveness of the vaccination in HCWs vary and include laboratory-confirmed influenza, clinically suspected influenza, work absenteeism and sickness presenteeism.

In the current study, which also seeks to measure the effectiveness of influenza vaccination among HCWs, some limitations are anticipated. Firstly, it is costly to measure influenza among HCWs and patients by laboratory confirmation, so this option could not be used. However, in a cross-sectional study, which is the design adopted for the current study, it is difficult to measure clinically suspected influenza by asking an individual about influenza symptoms or sickness presenteeism over one year because the symptoms are very common and self-reports will subject to recall bias. Thus, a prospective cohort study is a better option to minimize recall bias. However, due to the time limitation of the Doctor of Public Health (DrPH) programme, it is not feasible to conduct that type of study. Hence, we concluded that measuring work absenteeism would be the most appropriate and feasible way to be used as a proxy for the effectiveness of the influenza vaccination among HCWs in this study.

Table 2.6 presents a summary of the evidence thus far on the effectiveness of the influenza vaccination among HCWs.

Table 2.6 : Table of Evidence on the Effectiveness of the Influenza Vaccination among Healthcare Workers

Author (Year)	Study design	Study population	Occupational health	Employer	Patient safety	Finding
Burls et al. (2006)	Systematic review and meta-analysis	HCW, patients	Yes (HCW)	Yes	Yes	Influenza was highly effective
Kuster et al. (2011)	Systematic review and meta-analysis	58,245 participant's healthy adults and HCWs	Yes (HCW and healthy adults)	No	No	Incidence rates in HCWs were higher compare to in working adults. Rates of all infections were found to be lower in vaccinated HCWs than unvaccinated Conclude: Influenza vaccination is effective in protecting HCWs, reducing infections, both symptomatic and asymptomatic
Ng and Lai. (2011)	Systematic review and meta-analysis	Only 3 studies included involved 967 HCWs	Yes (HCW)	Yes	No	Due to limited studies included, did not allow the authors to make a definitive conclusion about the overall impact of the influenza vaccination on HCW themselves in terms of reduction of ILI, days with ILI symptoms and in the amount of sick leave
Michiels et al. (2011)	Systematic review	HCW; healthy adults (16–65 years); patients	Yes (HCWs and healthy adults)	Yes	Yes	The inactivated influenza vaccine shows efficacy in healthy adults and children There is little evidence that immunization is effective in protecting patients Not stated difference in a working day loss

“Continued”

Table 2.6: Table of Evidence on the Effectiveness of the Influenza Vaccination among Healthcare Workers

Author (Year)	Study design	Study population	Occupational health	Employer	Patient safety	Finding
Ferroni & Jefferson. (2011)	Systematic review	Healthy adults, patients	Yes (Healthy adults)	Yes	Yes	Inactivated vaccines are effective at reducing infection Mean difference workday lost: A good match is 0.21 Absent match/unknown is 0.09 Conclude: influenza vaccine may be marginally more effective than placebo
Wilde et al. (1999)	Randomized control trial	264 HCWs	Yes (HCW)	Yes	No	24/ 179 (13.4%) control subjects and 3/180 (1.7%) influenza vaccine recipients had serologic evidence of influenza type A or B infection during the study period. Decrease cumulative workday lost in the vaccinated group than the non-vaccinated group (9.9 per 100 subjects’ vs 21.1 per 100 subjects respectively, p-value 0.41)
Zaffina et al. (2019)	Cross sectional	2090 HCWs	No	Yes	No	Absenteeism is higher in unvaccinated HCWs than in vaccinated HCWs (an increase of 0.38 in average absenteeism in 2016/17 influenza season and increase of 0.46 in 2017/18 influenza season) (p-value <0.05) The total days lost in unvaccinated people are about 740 per year.

2.11 Theoretical framework

A theoretical approach is suitable to assess and predict vaccination behaviour. K.M Corace et al. (2016) conducted a systematic review to determine the use of behavioural theories to predict HCW influenza vaccination uptake. They found that researchers have adopted a wide range of behavioural theories to understand the attitude of HCWs towards vaccination such as health belief model (HBM), the triandis model of interpersonal behaviour, risk perception attitude, social cognitive theory and the theory of planned behaviour (K. M. Corace et al., 2016). In this chapter, we will discuss the theory of planned behaviour, social cognitive theory and health belief model to explain vaccination behaviour.

2.11.1 Theory of planned behavior

The theory of planned behaviour (TPB) was introduced by Icek Azjen, a professor of psychology (Ajzen, 1991). It has been used to address many health issues such as obesity, alcohol abuse and smoking (Ajzen, 1991). According to TPB, intentions predict health behaviour. The intention is influenced by attitudes, subjective norms and perceived behavioural control (Figure 2.4)

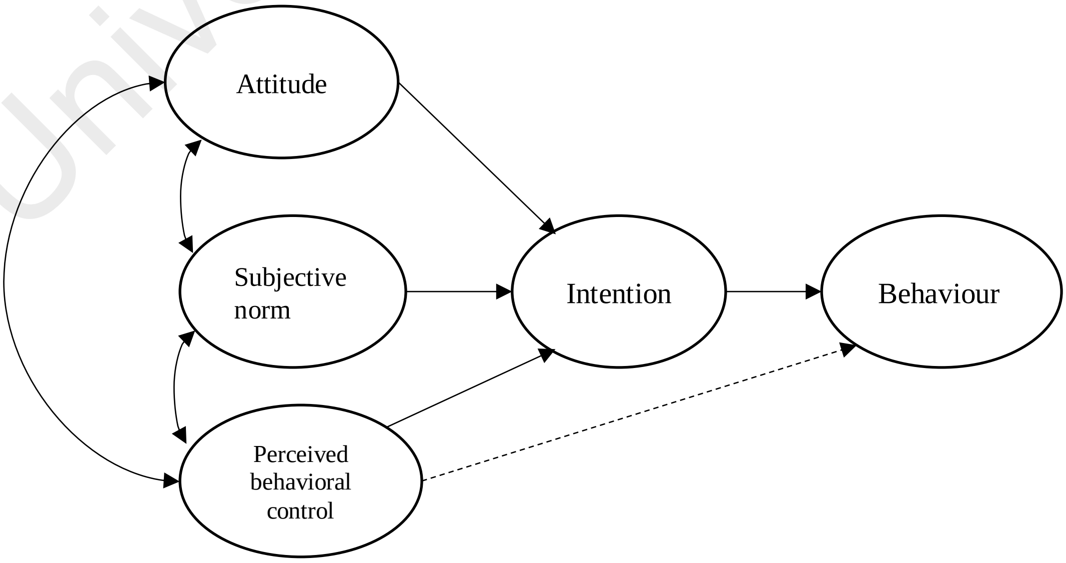

Figure 2.4: Theory of Planned Behaviour

Source: Icek Azjen (1991)

- **Attitudes:**

Attitude means a person's subjective evaluation of the behaviour and outcomes of the behaviour

- **Subjective norms:**

It refers to someone's assessments of whether close others would approve of the behaviour

- **Perceived behavioural control:**

It refers to a person's assessment of whether someone is ready and able to enact the behaviour.

Cornally et al used TPB to explain influenza vaccination behaviour among nursing student in Ireland (Cornally, Deasy, McCarthy, Moran, & Weathers, 2013). The study showed attitudes, subjective norms, and perceived behavioural control were significantly correlated with intention to get an influenza vaccination. However, in the multivariate logistic regression, the model only explained 41.9% of the variance in intention to get vaccinated.

2.11.2 Social cognitive theory

Social cognitive theory (SCT) is originally from research on Social Learning Theory. It was developed by psychologist Albert Bandura (Bandura, 1991). SCT aims to explain how people regulate their behaviour through control and reinforcement (Bandura, 1991). Ultimately, to achieve sustainable goal-directed behaviour. The core set determinants include reciprocal determinism, behaviour capability, observational learning, reinforcement, expectations and self-efficacy. Figure 2.5 shows the schematic presentation of social cognitive theory.

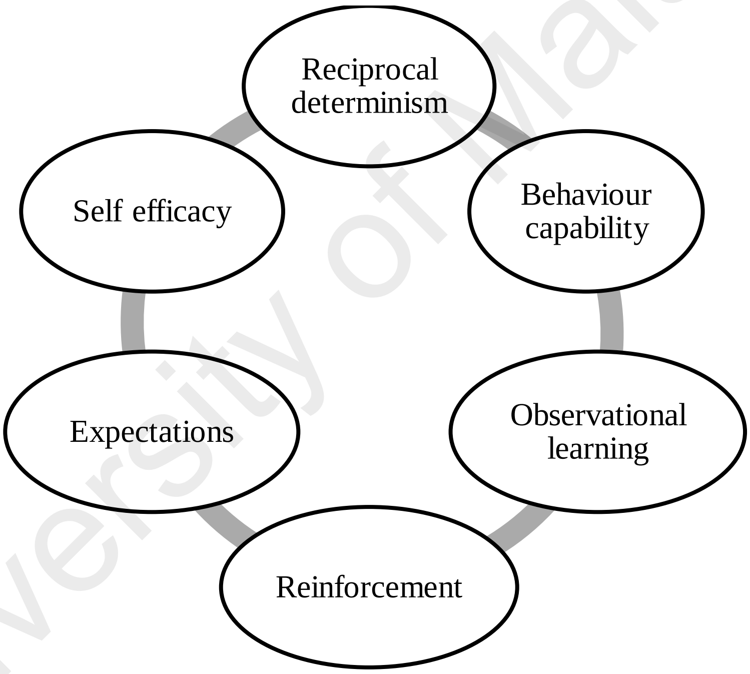

Figure 2.5 Social Cognitive Theory

Source: Bandura (1991)

- **Reciprocal determinism:**

Reciprocal determinism is the idea that behaviour is determined by reciprocal interaction between cognitive process, environment and behaviour. For example, the interaction between cognition and personality (person), situation (environment) and complexity or skills (behaviour).

- **Behaviour capability:**

  It refers to a person ability to perform behaviour through essential knowledge and skills. In another word, to perform a behaviour, a person must know what needs to be done and how to do it.

- **Observational learning**

  According to SCT, people who observe or witness behaviour conduct by others will then reproduce those actions.

- **Reinforcement:**

  It refers to the internal or external stimuli to a person's behaviour that affects the possibility to continue or discontinue the action. For example, any rewards, compliments or incentive

- **Expectations:**

  Expectations refer to the anticipated outcome or consequences of a person's behaviour. For example, "if I took influenza vaccination, then I will get protection against influenza."

- **Self-efficacy:**

  Self-efficacy refers to the level of confidence to perform behaviour. It can be influenced by that person's capabilities or other external factors.

There is limited study used social cognitive theory to explain influenza vaccination behaviour, hence, there is a lot more to explore (K. M. Corace et al., 2016). A cohort study by Ernsting et al aims to identify the social cognitive processes that determine influenza vaccination behaviour (Ernsting, Lippke, Schwarzer, & Schneider, 2011). The study found outcome expectancies and risk perception influenced intention to receive influenza vaccination and subsequently predicted the uptake. The limitation of this theory includes it is so broad, so it can be challenging to implement the approach entirely. Instead, implementation tends to focus on one or two constructs such as self-efficacy or outcome expectations.

2.11.3 Health Belief Model

The health belief model (HBM) was originally developed by a group of the U.S. public health researchers, including Hochbaum, Leventhal, Kegeles and Rosenstock in 1950 (Rosenstock, 1974). There are five constructs in the original version of the HBM: perceived susceptibility, perceived severity, perceived benefits, perceived barriers and cues to action as illustrated in Figure 2.6 (Rosenstock, 1974). More recent studies have added health motivators, attitude and self-efficacy to the model (Alenazi et al., 2018; Asma et al., 2016). The HBM has been used by various studies to explain the likelihood of influenza vaccination uptake (Asma et al., 2016; Cheung et al., 2017; Kwok et al., 2019; Kyaw et al., 2018; J. Lu et al., 2019; Payaprom, 2011; Shahrabani et al., 2009).

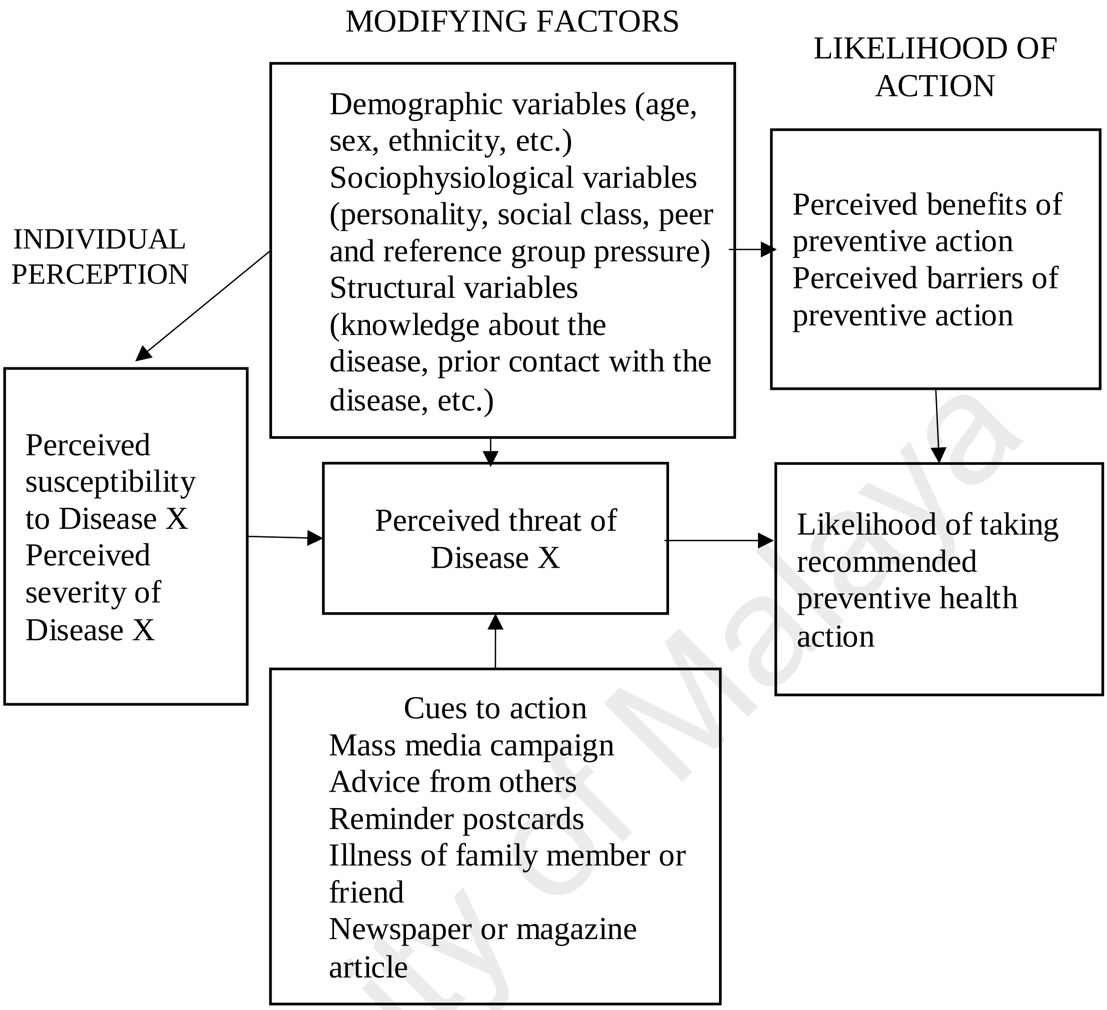

Figure 2.6: Health belief model
Source: Rosenstock (1974)

According to the HBM, for a person to avoid disease, he/she would need to believe that he/she was susceptible to the disease and the disease would have some severe effects on his/her life. Hence, taking preventive action would be beneficial in terms of reducing his/her susceptibility, or, if the disease occurred, in reducing its severity. At the same time, it would not involve barriers such as cost, inconvenience and pain.

Corace et al in their systematic review reported that HBM was found to be the most frequently employed theory to predict the factors associated with influenza vaccination uptake among HCWs (K. M. Corace et al., 2016). Hence, the conceptual framework for this study has been adapted from the HBM.

2.12 Conceptual framework

Figure 2.7 shows the conceptual framework for the current study. The conceptual framework posits that the likelihood of HCWs having an influenza vaccination is affected by their sociodemographic characteristics, knowledge about influenza and the vaccination, and their behaviours. These behaviours encompass their perceptions of their susceptibility to the disease and its severity as well as the barriers to and benefits of vaccination. The framework also considers the effects of social influence, health motivators, attitude and self-efficacy on the decision of HCWs to have an influenza vaccination. It also looks at the influence of health literacy (HL), a concept which is elaborated below when explaining the constructs of the HBM. Moreover, in the framework, it is postulated that the uptake of the influenza vaccination has an effect on work absenteeism.

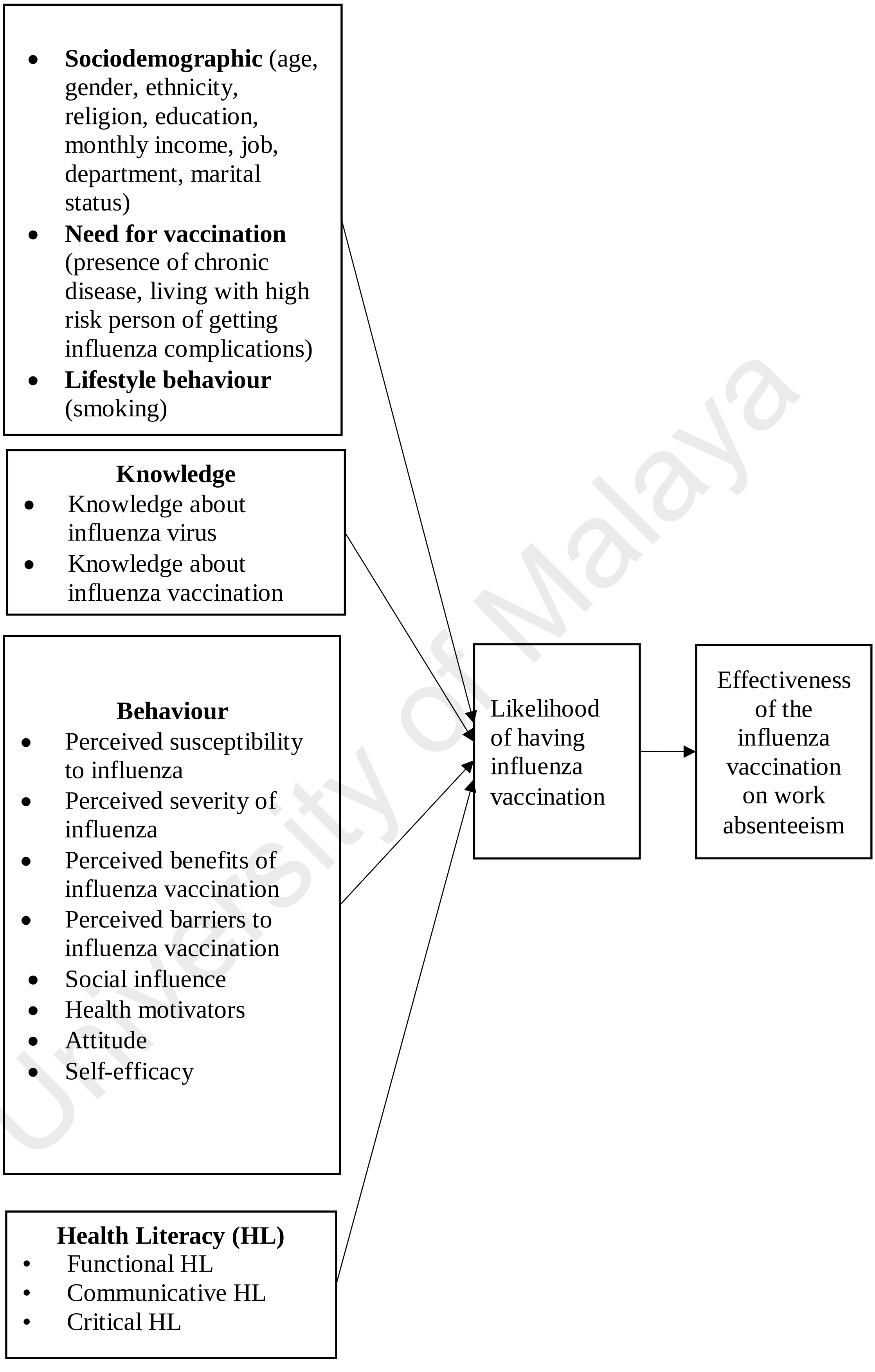

Figure 2.7: Conceptual framework adapted from the health belief model

In this study, we used the following extended HBM constructs:

- **Sociodemographic**:

  Sociodemographic variables such as age, gender, ethnicity, religion, education, monthly income, job, department, marital status can influence vaccination behaviour indirectly through its impact on individual's perception and perceived benefits of the influenza vaccination. Therefore, they also play an important effect on vaccination behaviour.

- **Need for vaccination:**

  Base on study by Asma et al (2016) need for vaccination referring to influenza-related risk factor include presence of chronic disease, living with high-risk person of getting influenza complications such as living with child aged less than 2 years, living with a person with a chronic disease, living with a person aged more than 65 years and living with a pregnant woman.

- **Lifestyle behaviour:**

  A healthy lifestyle behaviour has been found to be associated with higher influenza vaccination uptake (Wada & Smith, 2013). In this study, we include smoking behaviour to explain the likelihood of taking influenza vaccination.

- **Susceptibility to influenza:**

  Each individual has his/her perception of the likelihood of contracting influenza. At the low end of the susceptibility spectrum, the individual might deny that there is any possibility of them contracting the illness. In contrast, those at the high end may express the feeling that they are in real danger of contracting the disease. In short, susceptibility indicates the subjective risk of contracting the disease.

- **Severity of influenza:**

Belief about the severity of the disease may also vary among individuals. For instance, a person may see the severity of influenza in terms of pain and discomfort, physical disabilities or potentially death. Another person may think of the broader implications such as transmitting the disease to family members or work absenteeism and having to find temporary staff to replace the absent HCWs. On the other hand, another individual may think that the influenza infection is not serious, yet they might think it more severe if it spread within their own family and created psychological and economic stress.

- **Benefits of and barriers to the vaccination**:

The decision about taking the vaccination is also influenced by belief regarding the effectiveness or benefits of the vaccination in reducing the threat of the disease. However, at the same time, this perceived benefit may be counteracted by beliefs that the vaccination is inconvenient, costly, unpleasant or painful. These are some of the barriers that represent negative aspects of the health action (having a vaccination) and may lead to non-compliance of the vaccination.

- **Cues to action:**

Triggers to take the appropriate action that seems to be needed are also known as cues to action. They might be internal (e.g., perception of bodily state) or external (e.g., interpersonal interactions with work colleagues or family members, the impact of social media, or receiving reminders from the clinic).

- **Self-efficacy:**

  Self-efficacy is a belief in our abilities, specifically the ability to meet the challenges ahead of us and complete a task successfully (Akhtar, 2008). In relation to the issue of vaccination uptake, self-efficacy assesses HCW's confidence in their ability to obtain vaccination against influenza.

- **Attitude and health motivators:**

  Attitude and health motivators were added to the original HBM by some recent studies in order to assess the likelihood of taking influenza vaccination among HCWs (Alenazi et al., 2018; Asma et al., 2016). The term 'attitude' in the context of the current study can basically be described as a feeling or opinion about the influenza vaccination, particularly about having the right to choose to have or not have a vaccination or whether it should be mandatory for HCWs. Here, the term 'health motivation' refers to the degree of motivation to take vaccination and this motivation is mainly derived from having gained sufficient knowledge from reliable sources and also from having access to free vaccination (Asma et al., 2016).

Adding to the above, we also included the component of health literacy in the construct to explain the likelihood of having an influenza vaccination. Health literacy basically encompasses a person's knowledge, motivation and competences to access, understand, appraise, and apply health information. Health literacy allows a person to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion in order to maintain or improve their quality of life during their life course (World Health Organization, 2013b).

In this study, we use the definition of HL by Nutbeam that defined HL according to three levels, namely functional, communicative and critical HL (Nutbeam, 2000):

- **Functional HL:**

  Functional HL reflects the extent to which people had experience difficulty in reading or writing in order to function in daily task.

- **Communicative HL:**

  Communicative HL reflect the extent to which people had extracted and communicated information and apply the new knowledge to different situations.

- **Critical HL:**

  Critical HL reflects the extent to which people had critically analysed the information and used it to make decisions.

Glashen (2015) also used the HBM to explain HL and hypertension control in urban Latinos in New York City, so it seems a suitable approach to adopt for the current study.

2.13 Chapter Summary

The review of the literature presented in this chapter revealed that studies on the prevalence of and the factors associated with influenza vaccination uptake in Asian and middle- or low-income country are relatively scarce. It also showed that research on the effectiveness of the vaccination in temperate countries is also scant. Therefore, the sociodemographic characteristics, as well as the knowledge, behaviour and HL related to influenza vaccination among HCWs, need to be explored in the Malaysian setting. However, as highlighted by this literature review, to achieve this goal, a validated tool is required.

CHAPTER 3: METHODOLOGY

About this chapter

This chapter is about the materials and methods employed in this study. This study was divided into two phases. Phase 1 was a pilot study aimed to assess the psychometric properties of the Knowledge Questionnaire (KQ), Behavioural Determinants Questionnaire (BDQ) and Health Literacy Questionnaire (HLQ). KQ, BDQ and HLQ are the instruments used in Phase 2 of this study. Phase 2 was describing the prevalence of influenza vaccination among HCWs, its associated factors and the effectiveness of the influenza vaccination on absenteeism using the validated tools in Phase 1. This chapter described the methodology of the two phases in this study which include study design, study area, sampling procedure, study instruments, data collection procedure and the statistical approaches used to generate results of this study.

3.1 Phase 1: The psychometric assessment of the knowledge, behavioural determinants and health literacy questionnaire on influenza vaccination

3.1.1 Study design

The current study employed a cross-sectional study design that was aimed at examining the psychometric properties of the KQ, BDQ and HLQ related to influenza vaccination among HCWs.

3.1.2 Study area

The pilot study in Phase 1 was conducted in Hospital Shah Alam, which is located in Petaling District, Selangor (Figure 3.1). It is a tertiary hospital with a capacity of 300 beds. The hospital was selected to avoid contamination of the actual study conducted in Perak.

Figure 3.1: Location of Hospital Shah Alam, site of Phase 1 pilot study
Source: Google Maps

3.1.3 Study population

The pilot study was conducted among 100 HCWs. The inclusion criterion was all categories of HCWs who had contact with patients. This included all levels of HCWs such as doctors, pharmacists, staff nurses, assistant medical officers and others. The exclusion criterion was HCWs who refused to participate.

3.1.4 Study sample

The participants were selected by using convenience sampling because they are easily accessible to the researcher and availability at a given time (Etikan, Musa, & Alkassim, 2016).

3.1.5 Sample size calculation

It has been suggested that 10 to 30 participants are suitable sample size for a pilot study (Hill, 1998; Julious, 2005). Moreover, for test-retest reliability testing, a sample size of 50 is required for an intra-class correlation coefficient (ICC) of 0.8 and 95% CI ± 0.1 for two repeated measurements (De Vet, Terwee, Mokkink, & Knol, 2011). However, Connelly recommends a sample size of 10% of the sample required for the parent study (Connelly, 2008). Hence, the total sample size needed for the pilot study was 91 because the parent study needed 909 participants. However, 100 participants were recruited for the pilot study to ensure that there would be enough participants for the second measurement for reliability testing.

3.1.6 Study instrument for phase 1

The questionnaire developed for the pilot study consisted of five sections. Section one was aimed at gathering sociodemographic data on the participants, while section two focused on knowledge, section three on behavioural determinants, section four on HL and section five on uptake of influenza vaccination (Appendix F). Hereinafter, sections two to four are also sometimes referred to as independent questionnaires.

3.1.7 Study procedure

3.1.7.1 Item generation for the questionnaire

The items in the KQ and BDQ were adopted without modification from Tahir Mehmood Khan et al. (2016) and Asma et al. (2016), respectively. The items in the HLQ were adopted and modified from Ishikawa et al. (2008) to reflect the topic of influenza.

(a) ***Knowledge on influenza vaccination questionnaire (KQ)***

The measures in the knowledge on influenza vaccination questionnaire were based on those in the questionnaire developed by Tahir Mehmood Khan et al. (2016). The original questionnaire was intended to measure knowledge on influenza and influenza vaccination and was validated among HCWs giving a Cronbach's alpha of 0.87. The questionnaire is comprised of 11 items with multiple choice answers of 'true', 'false' and 'not sure'. There is only one correct answer. The correct answer is given 1 point, whereas incorrect and not sure answers are given 0 points. Thus, the total score ranges from a minimum score of 0 to a maximum score of 11.

(b) ***Behavioural determinants questionnaire (BDQ)***

The BDQ was adopted from Asma et al. (2016). The BDQ contains 46 questions which the respondents answer according to a five-point Likert scale (1 = 'strongly disagree', 2 = 'disagree', 3 = 'neutral', 4 = 'agree', 5 = 'strongly agree'). The primary domains of the questionnaire are based on the HBM and are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, motivating factors, social influence, attitude and self-efficacy.

Asma et al. (2016) adapted the questions that were used in a previous study among HCWs in nursing homes conducted in the Netherlands in 2005 (Looijmans-van Den

Akker et al., 2009). The adapted questionnaire was translated from the English language into the Turkish language and validated for use in Turkey giving a Cronbach's alpha of 0.92 (Asma et al, 2016). The English translation of the questionnaire in Asma et al. (2016) was available for publication purposes. We found that the English translation of the questionnaire by Asma et al. (2016) was almost similar to that of Looijmans-van Den Akker et al. (2009). Thus, the English translation of the questionnaire was considered acceptable and was translated into Bahasa Melayu, which is the national language of Malaysia, and validated in the Phase 1 study.

(c) ***Health literacy questionnaire (HLQ)***

The measures in the HLQ about HL related to influenza vaccination were based on those in the questionnaire developed by Ishikawa et al. (2008). The original questionnaire was designed to measure a broader dimension of HL, namely, functional, communicative and critical HL. It was validated among diabetic patients giving a Cronbach's alpha of 0.84, 0.77 and 0.65 for functional, communicative and critical HL, respectively. The questionnaire was adapted for the current study to reflect the topic of influenza vaccination. The adapted questionnaire consisted of 14 items the responses to which were ranked on a four-point Likert scale ranging from 1 = 'never' to 4 = 'often'.

3.1.7.2 Content validity

The content validation of the BDQ and HLQ (sections 3 and 4) was done by nine experts consisting of public health specialists, a family medicine specialist, an occupational health doctor and academicians. These experts reviewed the questionnaire individually and rated it based on the relevance of the questions. The KQ (section 2) was not sent for content validation as all the items were relevant and conclusive.

3.1.7.3 Face validity

To confirm face validity, the KQ, BDQ and HLQ were pretested on 10 randomly sampled students undertaking Doctor of Public Health (DrPH) and Master's in Public Health (MPH) programmes of study at the University of Malaya. The justification for selecting these participants was that they had a medical background and were the most easily accessible. This test was conducted to ensure the readability, feasibility and general formatting of the questionnaire. The questionnaire was revised according to the students' comprehension of the questions. The items were either edited, removed or left unchanged.

3.1.7.4 Translation

The KQ, BDQ and HLQ were translated into the national language of Malaysia (Bahasa Melayu) and then back-translated into English by two independent translators who are medical doctors. Both the original and back-translated English versions were reviewed by the researcher to confirm the accuracy of the translation.

3.1.7.5 Pilot test

The Bahasa Melayu version of the KQ, BDQ and HLQ was pilot tested on 100 HCWs at Hospital Shah Alam, Selangor. The participants were selected using convenience sampling. The study participants were HCWs who provided direct care to patients, so they represented all levels of HCW such as doctors, pharmacists, staff nurses, assistant medical officers and others.

3.1.7.6 Test-retest reliability

The KQ, BDQ and HLQ were completed again two weeks later by the same participants in order to assess its test-retest reliability. Out of the 100 baseline participants, 65 participated in the retest and returned useable questionnaire responses.

3.1.7.7 Data analysis

Descriptive statistics were used to describe the sociodemographic characteristics of the pilot study participants. The mean of the content validity index (I-CVI) was used to determine the content validity of the three domains (knowledge, behaviour and HL). Domains with a mean I-CVI of less than 1.0 were revised according to the experts' recommendation.

Reliability was expressed as the constancy of the particular instrument in producing the same result in repeated measurements. To determine the reliability of the whole questionnaire, the internal consistency of the knowledge domain was assessed by using Kuder–Richarson 20 (KR20) formula, whereas the behaviour and HL domains were assessed by using Cronbach's alpha (Koo, Poh, & Ruzita, 2016). A value of 0.7 or higher was considered to denote an acceptable KR20 or Cronbach's alpha coefficient (De Vet et al, 2011).

A corrected item-total score correlation was carried out to determine the correlation of each item with the relevant domain. A correlation value of less than 0.2 was deemed to indicate that the corresponding item did not correlate with the overall scale (Huang et al., 2006). Items with a value of less than 0.2 were discarded.

Test-retest reliability was determined by the ICC, where a correlation coefficient of 0.70 was used as the minimum standard for reliability and to indicate that the KQ, BDQ and HLQ had good reproducibility in line with De Vet et al. (2011). The data were analysed using STATA version 14.0 (serial number 301406227318).

3.2 Phase 2: Assessment of the factors associated with the uptake of influenza vaccination and the effectiveness of the influenza vaccination among healthcare workers

3.2.1 Study design

The Phase 2 study employed a cross-sectional design. The advantages of a cross-sectional design are that it is practical, convenient and cost-saving.

3.2.2 Study area

The study was conducted in Perak, which is located in the north of Peninsular Malaysia and has a population of 2.51 million (Department of Statistics Malaysia, 2018). Perak was selected because it has an existing influenza vaccination programme for HCWs, yet a substantial number of HCWs in the state do not avail themselves of the influenza vaccination. The study was conducted in two tertiary hospitals in Perak: Hospital Raja Permaisuri Bainun (HRPB) in Ipoh, Kinta District and Hospital Taiping in Taiping, Larut Matang & Selama district (figure 3.2).

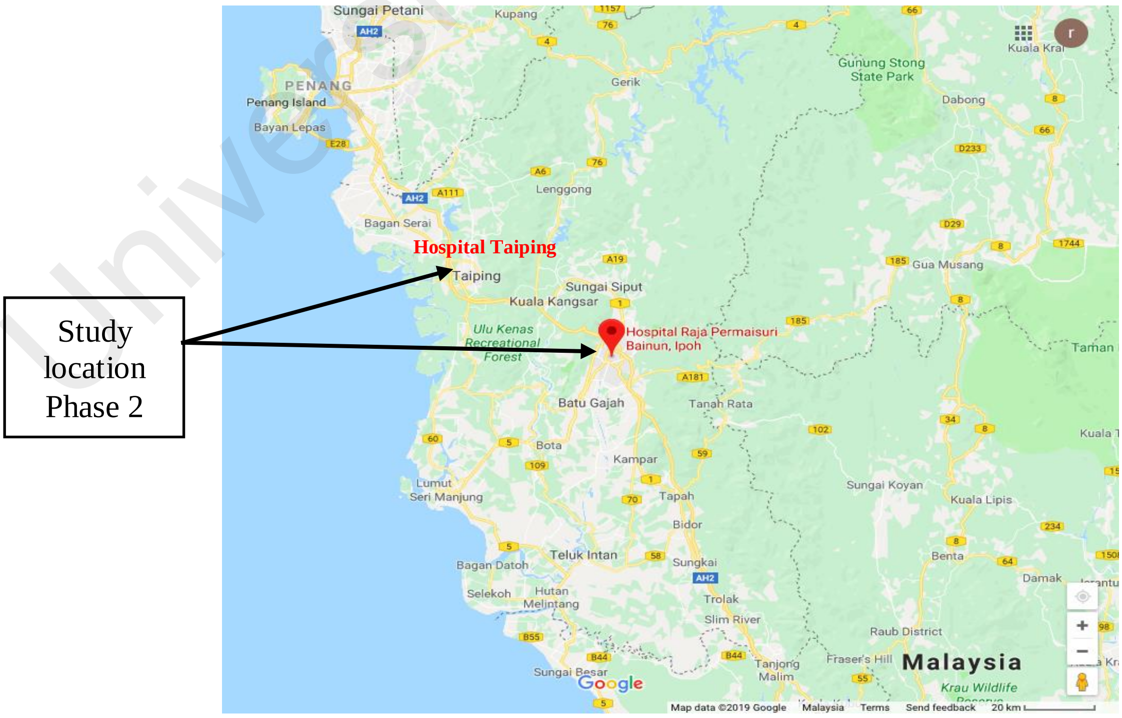

Figure 3.2: Map of Perak showing study location
Source: Google Maps

3.2.2.1 Hospital Raja Permaisuri Bainun, Ipoh

Hospital Raja Permaisuri Bainun is located in Ipoh, which is the capital city of Perak. As of 2010, Ipoh had a population of 657 892 (Department of Statistics, 2010). As at the time of the study, HRPB, which serves Ipoh and is also a public sector tertiary referral hospital, had 990 beds, making it the largest hospital in Perak and the third largest in Malaysia (Hospital Raja Permaisuri Bainun, 2018). The hospital provides basic speciality and sub-specialty services, including nephrology, respiratory medicine, haematology, neurosurgery, plastic surgery, and paediatric surgery. They had 4364 staff, including 174 specialists, 362 medical officers, 32 matrons, 129 sisters, 197 assistant medical officers, 1600 registered nurses, 164 community nurses and a large number of support staff (Human Resource Unit Hospital Raja Permaisuri Bainun, 2017). The hospital handled over 63, 289 in-patients in 2013, and the bed occupancy rate was 76.53% (Medical Record Unit Hospital Raja Permaisuri Bainun, 2014).

3.2.2.2 Hospital Taiping

Hospital Taiping is located in Taiping in Perak on Jalan Taming Sari. As the second-largest tertiary hospital in Perak, Hospital Taiping is a public sector hospital and acts as a referral centre for the district hospitals of Parit Buntar, Selama, Gerik, Kuala Kangsar and health clinics nearby. It provides services to a population of approximately 744 100 living in the districts of Larut Matang & Selama, Manjung (Pantai Remis area), Kerian and Kuala Kangsar (Hospital Taiping, 2018). At the time of the study, Hospital Taiping had a total of 2,485 staff (professional and support services), including 49 specialists, 227 medical officers, nine matrons, 80 sisters, 777 registered nurses, 143 community nurses and 119 assistant medical officers (*Human Resource Report*, 2017). Hospital Taiping handled over 284,845 outpatients and 45 987 in-patients in 2017. The bed occupancy rate in 2017 was 68.66% (Medical Record Unit Hospital Taiping, 2017).

3.2.3 Study period

The study was conducted for a period of 16 months from 1 September 2017 until 31 December 2018. During that time, the data collection period lasted for 3 months from 1 December 2017 until 28 February 2018.

3.2.4 Study population

The participants in this study were front-line nurses and assistant medical officers at HRPB and Hospital Taiping. Among all HCWs, assistant medical officers and nurses constitute the largest group and have the highest frequency of contact with patients and other staff (Bernard et al., 2009), which justifies the importance of studying this group of HCWs.

3.2.4.1 Inclusion criteria

In this study, the eligible participants were nurses (including sisters, registered nurses and community nurses) and assistant medical officers who had been working in HRPB and Hospital Taiping for a minimum period of 12 months. The period of employment was verified with the human resources department. The participants could be working in any outpatient unit or inpatient unit but had to be involved in providing direct care to patients.

3.2.4.2 Exclusion criteria

The exclusion criteria include those who refused to participate.

3.2.5 Sample size

The sample size was calculated by using the sample size formula for a cross-sectional study and the main outcome measures (study objectives) (Pourhoseingholi et al, 2013), as described in the subsequent subsections.

3.2.5.1 Sample size calculation based on the formula

The sample size was calculated using the sample size formula for estimating the minimum sample size in a cross-sectional study: $N = Z^2pq/d^2$ (Pourhoseingholi et al, 2013). The use of a vaccination coverage rate of 51% (Hudu et al, 2016) resulted in a minimum sample size required for this study of 384:

$$N = Z^2pq/d^2$$
$$= (3.84 \times 0.51 \times 0.49) / 0.0025$$
$$= 384$$

Where:

Z = standard normal deviation, set at 1.96 which corresponds to a 95% CI

p = proportion in the target population estimated to have a particular characteristic

q = 1-p (proportion in the target population not having the particular characteristic)

d = degree of accuracy required, which was set at the 0.05 level.

3.2.5.2 Sample size calculation based on the study objectives

Open Epi software was used to calculate the sample size based on the outcome measures or study objectives. For this sample size calculation, the CI was set at 95% with a power of 80%. Table 3.1 shows the result of the sample size calculation based on the two main study objectives.

Table 3.1: Sample Size Calculation Based On Study Objectives

Objective	**Type 1 error**	**Power**	**Odds ratio/risk difference**	**Ratio of unexposed to exposed group**	**Sample size required**
To determine the association between the health literacy of HCWs and their uptake of the influenza vaccination; (Scott et al., 2002)	0.05	0.8	1.7	0.45	699
To determine the effectiveness of the influenza vaccination on absenteeism among healthcare workers (Bridges et al., 2000)	0.05	0.8	32	1.0	72

To calculate the final sample size, we took the highest sample size required according to calculations based on the formula and study objective approaches and added a 30% non-response rate, which gave a final sample size of 909.

Final sample size, n = 699 + 30% (non-response rate)
= 908.7
= 909

3.2.6 Sampling procedure

The sampling for this study was conducted using multistage random sampling. Random sampling was used to allow for generalizations from a small representative sample of the general population and also to mitigate selection bias. Out of the 15 public hospitals in Perak, two hospitals were randomly chosen: 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. An attempt to recruit more participants was made by distributing 1100 questionnaires in total: 700 to HRPB and 400 to Hospital Taiping. The difference in the number of questionnaires distributed to each establishment was based on the staff numbers in each hospital. The flow of the sampling procedure is shown in Figure 3.3.

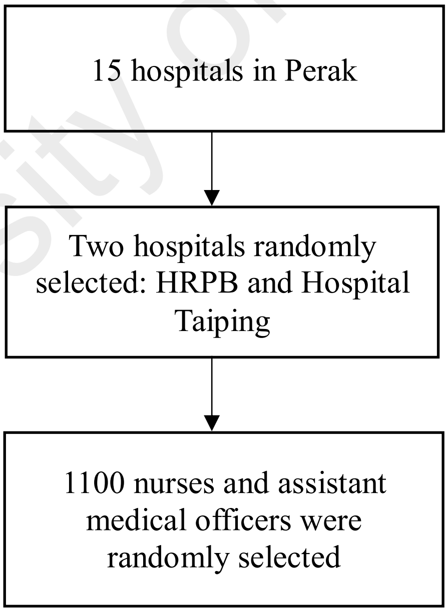

Figure 3.3: Flow of sampling procedure

3.2.7 Study instrument

The study instrument for Phase 2 consisted of five sections. Section one gathered sociodemographic, the need for vaccination and lifestyle behaviour (smoking) data of study participants. While section two consisted of knowledge questionnaire, section three on behaviour determinants questionnaire, section four on HL questionnaire and section five on influenza-related work absenteeism (Appendix G). Hereinafter, sections two to four are also sometimes referred to as independent questionnaires. While section five is referred as dependent variables. Information on vaccination status was obtained from the immunization record held by the Public Health Unit of the studied hospitals

3.2.7.1 Sociodemographic information

The following sociodemographic information was collected from the participants: age, gender, ethnicity, education level, religion, job category, department, monthly income and marital status.

3.2.7.1 Need for influenza vaccination

The need for influenza vaccination was based on living with a member of a group at high risk of getting influenza complications and the presence of chronic disease.

3.2.7.2 Lifestyle behaviour

The lifestyle behaviour that was measured in this study was smoking status.

3.2.7.3 Knowledge questionnaire

The questionnaire used to measure knowledge was based on the questionnaire developed by Tahir Mehmood Khan et al. (2016). The original questionnaire consisted of 11 items and was validated among HCWs, giving a Cronbach's alpha of 0.87. In Phase 1 of the current study, the original questionnaire was translated into the national language of Malaysia (Bahasa Melayu) and subjected to a validation process. However, after the validation process in Phase 1 was fully completed, only eight of the original 11 items were retained. The calculation of reliability using the KR20 formula for the 8-item produced a value of 0.5768, which was considered acceptable (Gliner, 2000).

The resulting 8-item knowledge questionnaire was used to measure knowledge on influenza and influenza vaccination. The participants respond to the items by selecting a multiple choice answer of either ‘true’, ‘false’ or ‘not sure’. There was only one correct answer to each item. 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.

3.2.7.4 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. (2016), which was based on the HBM. The original questionnaire contained 46 items. However, as a result of the validation process performed in Phase 1 of this study, six items were discarded due to their poor correlation within the barrier construct. The remaining 40 items fell under the eight constructs of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, motivating factors, social influence, attitude and self-efficacy.

Perceived susceptibility was measured by four items (e.g., “I have a high risk of contracting influenza.”). Perceived severity was assessed by three items (e.g., “Influenza is dangerous for me.”). Perceived benefits were assessed by four items (e.g., “Vaccination reduces my personal risk of influenza.”). Perceived barriers were assessed by 10 items (e.g., “I find an injection every year uncomfortable.”). Motivating factors were measured by five items (e.g., “The Ministry of Health provides free vaccination for healthcare workers.”). Social influence was measured by five items (e.g., “My relatives believe that my vaccination is important.”). Attitude was measured by four items (e.g., “I feel it is important that healthcare workers do not spread the disease to their patients.”). Self-efficacy as assessed by five items (e.g., “I would get vaccinated every year if I had enough time.”).

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 (Asma et al, 2016), 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. Note that some items in the perceived barriers construct were reverse coded for ease of interpretation.

3.2.7.5 Health literacy questionnaire

The questionnaire that was used to measure HL was the same as the one developed by Ishikawa et al. (2008), except that it was translated into Bahasa Melayu. It consists of 14 items covering three dimensions of HL: functional, communicative and critical. The questionnaire was validated in Phase 1 of the study, giving a Cronbach’s alpha of 0.79, 0.92, and 0.93 for functional, communicative and critical HL, respectively.

Functional HL was assessed by five items that addressed the extent to which participants had experienced difficulties in reading instructions or leaflets regarding influenza vaccination. Communicative HL was evaluated by five items that assessed the extent to which participants had extracted and communicated information about the influenza vaccination. Critical HL was assessed by four items that focused on the extent to which participants had critically analysed the information on influenza vaccination and used it to make decisions.

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) (Ishikawa et al., 2008). The scores were reversed for functional HL such that a higher score indicated a higher HL.

3.2.7.6 Influenza vaccination uptake

To assess the prevalence of vaccination uptake, information on vaccination status was obtained from the immunization record held by the Public Health Unit of the studied hospitals during the period between 1 November 2016 and 31 December 2016. Everyone was offered and accessible to influenza vaccine during this period.

3.2.7.7 Influenza-related work absenteeism

To assess the effectiveness of the influenza vaccination, participants were asked about their influenza-related work absenteeism which, as explained in section 2.10, was used as a proxy for vaccination effectiveness. The specific question that was posed was: “In 2017, how many days did you take sick leave due to ILI symptoms such as fever, cough, sore throat, runny nose, muscle or body aches, headache, tiredness and acute respiratory tract infection?” When an extreme value (more than seven days) was given for the number of sick days, the data was verified by checking it against medical records or via a discussion with the participant’s physician. All information regarding sick leave are captured after respondent having their influenza vaccination (based on the secondary data as explained in 3.2.7.6).

3.2.8 Study variables

In this section, the study variables are described according to the objectives of Phase 2 of the study. Table 3.2 shows independent and dependent variables for each objective.

Table 3.2: Independent and Dependent Variables for each Objective

Objectives	Independent variables	Dependent variables
• To evaluate sociodemographic characteristics, knowledge, behavioural determinants and health literacy regarding influenza vaccination among healthcare workers	Sociodemographic characteristics, knowledge, behavioural determinants, HL	NA
• To determine the association between the sociodemographic characteristics, knowledge, behavioural determinants and health literacy of healthcare workers and their uptake of the influenza vaccination	Sociodemographic characteristics, knowledge, behavioural determinant, HL	Influenza vaccination uptake
• To determine the effectiveness of the influenza vaccination on absenteeism among healthcare workers	Influenza vaccination uptake	Influenza-related absenteeism

NA: not applicable

3.2.9 Operational definitions

3.2.9.1 Age

Age was based on the date of birth recorded on the participant's national identification card.

3.2.9.2 Gender

Gender was categorized into male and female.

3.2.9.3 Ethnicity

Ethnicity was classified into Malay, Chinese, Indian or others. For the logistic regression, the race was categorized into Malay and non-Malay (Chinese, Indian, others).

3.2.9.4 Religion

Religion was classified into Islam, Buddhism, Hinduism, Christianity or others. For the logistic regression, religion was categorized into Muslim and Non-Muslim (Buddhists, Hindus, Christians, others)

3.2.9.5 Education level

Education level was divided into three categories: primary school, secondary school and tertiary education. Tertiary education was further categorized into Diploma, Bachelor's, Master's or PhD. Participants recorded only their highest level of education.

3.2.9.6 Job category

Jobs were categorized into sisters (ward manager), registered nurses, community nurses and assistant medical officers

3.2.9.7 Department

Departments were categorized into medical, surgical, obstetrics & gynaecology, anaesthesiology, paediatric, orthopaedic, emergency and other departments. The other departments' category included neurosurgery, psychiatry, ophthalmology, dermatology, haemodialysis, forensic, and management. Primary care services were not available in the studied hospital, where the emergency department acted as the first responder. Participants were asked to give the name of the department in which they were currently working.

3.2.9.8 Monthly income

The monthly income of the participants was defined as basic salary and allowances per month as detailed on the payslip. On-call and extended hour payments were excluded. The income was categorized into four bands: less than Ringgit Malaysia (RM)1,000, RM1,001-3,000, RM3,001-5,000, more than RM5,001. This was done to prevent missing data; in the pilot study in Phase 1 a lot of the participants refused to expose their actual income.

3.2.9.9 Chronic disease

Participants were asked if they had any chronic disease such as hypertension, diabetes, heart disease, lung disease or others.

3.2.9.10 Marital status

Marital status was classified into married, separated, divorced, widowed and single. For the logistic regression, marital status was categorized into married and non-married (separated, divorced, widowed and single).

3.2.9.11 Living with a person at high risk of developing influenza complications

The participants were asked if they were living with one of the following four types of person at high risk of developing influenza complications: a person aged > 65 years, a child aged < two years, person with chronic disease and pregnant woman.

3.2.9.12 Smoking status

Smoking status was categorized into: smoking, previously smoked and never smoked. Smoking was defined as currently smoking cigarettes, pipes or cigars or chewing tobacco at the time of the study. Previously smoked was defined as having stopped smoking for 6 months. Never smoked was defined as never having taken up smoking. For the logistic regression, the status of smoking was further categorized into smoking and non-smoking (previously smoked and never smoked).

3.2.9.13 Knowledge about influenza and the influenza vaccination

Knowledge about influenza and the influenza vaccination was defined as knowledge about the modes of transmission, signs and symptoms of influenza and the content of the influenza vaccine itself.

3.2.9.14 Behavioural determinants

The behavioural determinants that were used to assess the behaviours that might have an effect on the HCW having an influenza vaccination consisted of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, motivating factors, attitude, social influence, and self-efficacy. Participants who agreed or strongly agreed with any of the items covering the above determinants were given a score of 1 for each of those items. Participants who gave a neutral response or disagreed or strongly disagreed with the items were given a score of 0 for each of those items. Negative statements were reversed scored for ease of interpretation.

3.2.9.15 Health literacy related to influenza vaccination

Health literacy related to influenza vaccination refers to three levels HL include functional HL, communicative HL and critical HL.

3.2.9.16 Influenza vaccination uptake

Uptake of the influenza vaccination was defined as the participant taking the vaccination during the period between 1 November 2016 and 31 December 2016 and there is a record in the immunization database held by the Public Health Unit in the studied hospital.

3.2.9.17 Influenza-related work absenteeism

Influenza-related work absenteeism was defined as sick leave due to any ILI symptom (fever, cough, runny nose, sore throat, muscle or body aches, headache, tiredness) and acute respiratory tract infection during the year 2017.

The effectiveness (%) of the influenza vaccination on the rate of absence (ROA) was calculated as follows: 100 × (ROA in the non-vaccinated group—ROA in the vaccinated group) / ROA in the non-vaccinated group.

ROA was calculated as the number of sick days/number of subjects in the study (Abu H Samad et al., 2006)

3.2.10 Data collection and verification

This study used a self-administered questionnaire to collect the required data. The researcher was helped by the matron or sister in charge of the various departments to identify the participants and distribute the questionnaires. The participants were given two weeks to complete the questionnaire. The returned questionnaires were checked from time to time by the researcher to minimize the missing data. A mopping-up procedure was followed by the researcher in order to deal with incomplete or missing data, where the researcher returned the questionnaires to the respective departments and collected them after one week.

As mentioned above, the vaccination uptake was based on the immunization records held by the Public Health Unit in the studied hospitals. The questionnaire also asked the participants about the amount of sick leave. Any extreme values were verified by checking them against the participant's medical record or via discussion with the participant's physician.

3.2.11 Data management

3.2.11.1 Data entry

Following data collection, data entry was performed by the main researcher using Research Electronic Data Capture (REDCap). The data from the questionnaires were entered into REDCap to minimize the transcription errors. In addition, double data entry was used to identify errors, missing data or discrepancies. Double data entry was performed on 80 of the questionnaires (10%) by an independent data entry person. The questionnaires were randomly selected using STATA software. The researcher double-checked and compared both datasets to identify errors, missing data and discrepancies. Any discrepancies were clarified with the data entry person. The data in REDCap was then exported to STATA for further analysis. It was kept in four back-up files in a separate device and locked with a password. Only the main researcher has access to the complete dataset.

3.2.11.2 Data cleaning

Frequency analysis, histograms and box plots were used to identify duplicates, missing data and any outliers. The original questionnaire papers were compared against the entered data to check for transcription errors and were corrected accordingly or returned to the respondents for clarification. Any actual missing data were subjected to further analysis. Furthermore, a normality test was done using the Shapiro–Wilk test.

3.2.11.3 Missing data analysis

The missing completely at random (MCAR) assumption assumes that the missingness of data is independent of both the observed and the unobserved data (Li, 2013). Little's test was performed to test for MCAR (Li, 2013). If the p-value of Little's test is more than 0.05, the data can be assumed MCAR. In this case, multiple imputations are not needed. Hence a complete case analysis was performed. Figure 3.4 illustrates the flow of the data collection and analysis process. A total of 1100 questionnaires were distributed. 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 consented and returned the questionnaire, 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.

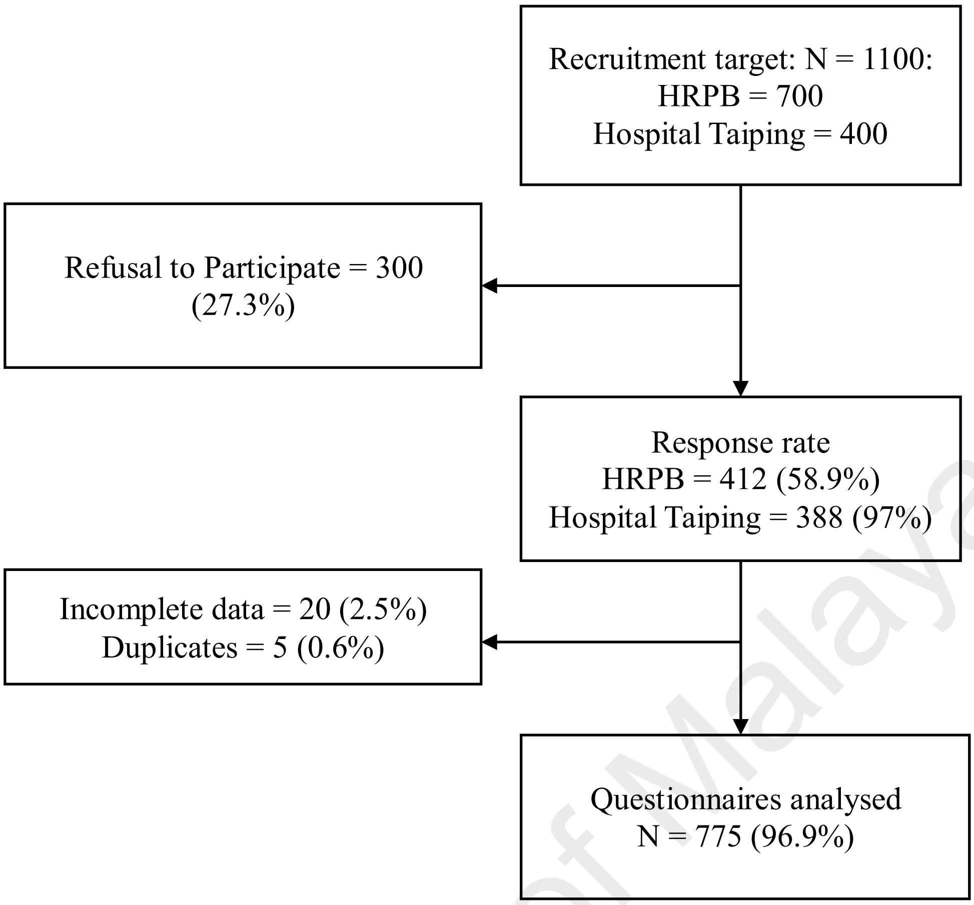

Figure 3.4: Flow of data collection and analysis process

3.2.12 Statistical analysis

Descriptive statistics were used to describe the sociodemographic characteristics of the study participants. The prevalence of influenza vaccination uptake was reported as a percentage. Comparisons between the vaccination uptake and the non-vaccination uptake groups were performed by using the chi-square or Fisher exact test for categorical data and the t-test or Mann–Whitney U test for numerical data. Effects of the independent variables on vaccination uptake were evaluated by using univariate logistic regression analysis.

To study the effect of the independent variables on vaccination uptake, the independent variables were modelled against the vaccination status by using multiple logistic regression. In the multiple logistic regression, both stepwise forward and stepwise backward were used to determine the factors associated with influenza vaccination. Then the results (odds ratio and coefficients) from both methods were compared. It is important to note that, four models were tested based on the conceptual framework which derived from the HCWs influenza vaccination literature. In model 1, the sociodemographic characteristics were investigated as predictors for vaccination uptake. In model 2, knowledge was added to the variables in model 1. In model 3, behavioural determinants were added to the variables in model 2. In model 4, HL was 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. Regression results were summarized by using the adjusted odds ratio, a 95% confidence interval and the p-value.

Furthermore, correlation analysis was conducted to test for the presence of multicollinearity between the independent variables. To assess the goodness of fit, the Hosmer–Lemeshow test, classification table and area under the receiver operating characteristics (ROC) curve were tested. All analyses were performed using STATA version 14.0 (serial number 301406227318).

3.2.13 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. The study participants were provided with an informational sheet that described the study. Written informed consent was obtained from the participants, and the responses were kept strictly confidential.

As mentioned above, data entry was performed using REDCap. This is a secure web-based database, where only specific users with a password can gain access to data. The researcher set strict data access rules that were specific to the role of each of the persons involved in the study (e.g., project manager, research assistant or data entry person).

The data will be kept for five years and will be destroyed after that. The questionnaires will continue to be kept in a locked cabinet. All the information obtained in this study will be handled in a confidential manner, in accordance with applicable laws and/or regulations. When publishing or presenting the study results, the identities of the participants will not be revealed without their express consent. Individuals involved in this study, qualified monitors and auditors, the sponsor or its affiliates and governmental or regulatory authorities may inspect and copy the medical records, where appropriate and necessary.

3.3 Chapter summary

This chapter described the study methodology for phase 1 and phase 2 of this study. Phase 1 was a pilot study aimed to assess the psychometric properties of the KQ, BDQ and HLQ. Phase 2 was a cross sectional study describing the prevalence of influenza vaccination among HCWs in Perak, its associated factors and the effectiveness of the influenza vaccination on absenteeism using the validated questionnaires in Phase 1. The dependent variable was influenza vaccination uptake, and four independent variables were sociodemographic, knowledge, behavioural determinants and health literacy. Influenza-related work absenteeism was also a dependent variable. The data were analysed using STATA version 14.0.

CHAPTER 4: RESULTS

About the chapter

This chapter presents the finding of this study. The first part presents the results of psychometric testing of the KQ, BDQ and HLQ (Phase 1). The second part presents the findings of Phase 2 study and presented in three subsections 1) Descriptive analysis of prevalence and factors associated with influenza vaccination uptake, 2) Association between influenza vaccination uptake and risk factors 3) Effectiveness of influenza vaccination on work absenteeism

4.1 Phase 1: The psychometric assessment of the knowledge, behavioural determinants and health literacy questionnaire on influenza vaccination

This section presents the findings of the psychometric assessment of the Knowledge (KQ), Behavioural Determinants (BDQ) and Health Literacy Questionnaire (HLQ). The first subsection deals with the content and face validation of the questionnaire. The next subsection describes the characteristics of the study population and presents the results of the reliability analysis (pilot test). Then the following subsection presents the results of the test-retest reliability analysis.

4.1.1 Content and face validation of knowledge, behavioural determinants and health literacy questionnaire

Nine experts did the content validation of the BDQ and HLQ. The KQ was not sent for content validation as all the items were relevant and conclusive. As for the BDQ, the content validation produced the following mean I-CVI values: 0.81 (perceived susceptibility), 0.92 (perceived severity), 0.94 (perceived benefits), 0.77 (perceived barriers), 1.00 (motivating factors), 0.90 (social influence), 0.88 (attitude) and 1.00 (self-efficacy). Domains with a mean I-CVI of less than 1.0 were revised according to experts' recommendations.

As regards the HLQ, the mean I-CVI values for functional, communicative and critical HL were 1.00, 0.96 and 0.95, respectively. As the items on communicative and critical HL were considered to be an important component of the theoretical definition of HL, we decided to retain all the items and amended them according to the experts' suggestions.

The questionnaire was then pretested on 10 MPH/ DrPH students to assess its face validity. Out of the ten students, five asked for clarity on some confusing words. Based on the content and face validation, some of the items were revised and rearranged to improve better understanding and comprehension.

4.1.2 Sociodemographic characteristics of participants of reliability testing

The questionnaire was pilot tested in Hospital Shah Alam, Selangor. A total of 100 questionnaires were distributed among HCWs for the pilot test. For the test-retest reliability assessment, a total of 65 respondents from among the original 100 respondents completed the questionnaire for the second time, giving a response rate of 65%. The sociodemographic characteristics of the study participants are listed in Table 4.1.

Table 4.1: Characteristics of the Participants in the Pilot Test

Characteristic	N = 100
Age (years), mean (±SD)	32.74 (±7.79)
Gender	
Male	23
Female	77
Ethnicity	
Malay	93
Chinese	5
Indian	1
Others	1
Religion	
Islam	95
Buddhism	3
Christianity	2
Education	
Secondary school	25
Tertiary	75
Job category	
Doctor	17
Pharmacist	4
Assistant medical officer	7
Nurse	44
Health assistant	8
Others	20

4.1.3 Reliability testing of the knowledge, behavioural determinants and health literacy questionnaire

4.1.3.1 Knowledge questionnaire

Table 4.2 shows the internal consistency results for the knowledge questionnaire. A correlation value of less than 0.2 indicates that the corresponding item does not correlate with the overall scale and should, therefore, be discarded (Huang et al., 2006). From the table it can be seen that items B05, B06 and B08 had a corrected item-total score correlation of less than 0.2, indicating poor correlation. It was, therefore, appropriate to remove these three items from the questionnaire. The KR20 value for the knowledge domain with all 11 items was 0.5408.

Table 4.2: Internal Consistency of the Knowledge Questionnaire

Domain and items	Corrected item-total score correlation
B01	0.3049
B02	0.4606
B03	0.3054
B04	0.3506
B05	**0.1161**
B06	**0.1939**
B07	0.2733
B08	**0.0973**
B09	0.2098
B10	0.2128
B11	0.2454

Table 4.3 shows the internal consistency result and test-retest reliability results after items B05, B06 and B08 were deleted. A corrected item-total score correlation value of more than 0.2 indicates that the items correlate well with the overall scale (Huang et al., 2006). When these three items had been removed, all the remaining items had a value greater than 0.2. Moreover, due to the removal of the three items, the KR20 value of the knowledge scale increased to 0.5768 to show moderate reliability. A reliability coefficient of 0.5768 can be considered as reliable and acceptable (Gliner, 2000). The ICC for all the items ranged from 0.51 to 0.84, which indicated moderate to good reliability (De Vet et al., 2011).

Table 4.3: Internal Consistency and Test-Retest Reliability Results for the Knowledge Questionnaire after Deletion of Items B05, B06 and B08

Domain and items	Corrected item-total score correlation	Intra-class coefficient correlation
B01	0.3514	0.79
B02	0.4780	0.56
B03	0.3121	0.56
B04	0.3968	0.51
B07	0.2305	0.73
B09	0.2247	0.84
B10	0.2531	0.79
B11	0.2440	0.80

4.1.3.2 Behavioural determinants questionnaire

Table 4.4 shows the internal consistency and test-retest reliability results for the BDQ. This questionnaire had 46 items under eight domains, namely perceived susceptibility, perceived severity, perceived benefits, perceived barriers, motivating factors, social influence, attitude and self-efficacy.

Table 4.4: Internal Consistency and Test-Re-Test Reliability Results for the Behavioural Determinants Questionnaire

Domain and items	Corrected item-total score correlation	Cronbach's alpha if item deleted	Cronbach's alpha	Intra-class coefficient correlation
Perceived susceptibility				
C01	0.6963	0.6055	0.6633	0.80
C02	0.6956	0.6062		0.87
C03	0.6727	0.6285		0.75
C04	0.7566	0.5405		0.84
Perceived severity				
C05	0.8995	0.9802	0.9697	0.79
C06	0.9715	0.9281		0.78
C07	0.9333	0.9559		0.78
Perceived benefits				
C08	0.6469	0.7665	0.8175	0.75
C09	0.7228	0.7300		0.78
C10	0.7933	0.6948		0.77
C11	0.4178	0.8672		0.85
Perceived barriers				
C12	0.3201	0.7110	0.7244	0.89
C13	**0.1102**	0.7320		0.87
C14	**0.0482**	0.7379		0.88
C15	**0.0285**	0.7398		0.89
C16	0.4221	0.7003		0.78
C17	0.6424	0.6762		0.92
C18	**0.1307**	0.7300		0.84
C19	0.4812	0.6940		0.90
C20	**0.1325**	0.7298		0.89
C21	0.3537	0.7075		0.79
C22	0.2629	0.7168		0.91
C23	**0.1971**	0.7234		0.86
C24	0.3223	0.7107		0.79
C25	0.4149	0.7011		0.90
C26	0.5837	0.6828		0.92
C27	0.7151	0.6680		0.93

"Continued"
Table 4.4: Internal Consistency and Test-Re-Test Reliability Result of Behaviour Determinants Questionnaire

Domain and items	Corrected item-total score correlation	Cronbach's alpha if item deleted	Cronbach's alpha	Intra-class coefficient correlation
Motivating factors				
C28	0.6366	0.7197	0.7851	0.78
C29	0.6445	0.7170		0.81
C30	0.5646	0.7439		0.87
C31	0.5293	0.7554		0.84
C32	0.4383	0.7842		0.81
Social influence				
C33	0.5021	0.8922	0.8731	0.83
C34	0.6981	0.8467		0.82
C35	0.7110	0.8436		0.81
C36	0.8195	0.8164		0.81
C37	0.7864	0.8249		0.79
Attitude				
C38	0.5653	0.6727	0.7457	0.75
C39	0.6995	0.5929		0.75
C40	0.3717	0.7767		0.82
C41	0.5412	0.6864		0.77
Self-efficacy				
C42	0.6378	0.7116	0.7806	0.86
C43	0.6343	0.7128		0.87
C44	0.5124	0.7539		0.79
C45	0.4158	0.7847		0.90
C46	0.5834	0.7303		0.83

The results in the table show that the corrected item-total score correlation for each domain was above 0.2, except for the perceived barriers domain. Therefore, the items in this domain that had a correlation below 0.2 were deleted. These items were C13, C14, C15, C18, C20 and C23, which had a corrected item-total score correlation of 0.1102, 0.0482, 0.0285, 0.1307, 0.1325 and 0.1971, respectively. Cronbach's alpha exceeded 0.66 for all domains, and this was considered acceptable (Gliner, 2000).

Table 4.5 shows the internal consistency and test-reliability results after deletion of the six items (C13, C14, C15, C18, C20 and C23) in the perceived barriers domain. It can be seen that the corrected item-total score correlation ranged from 0.2220 to 0.7312. Overall, Cronbach's alpha was 0.7880, which indicated good internal consistency (Gliner, 2000). The ICC ranged from 0.75 to 0.93, which indicated good to excellent reliability (De Vet et al., 2011).

Table 4.5: Internal Consistency and Test-Retest Reliability Results for the Behavioural Determinants Questionnaire after Deletion Six Items in the Perceived Barriers Domain

Domain and items	Corrected item-total score correlation	Cronbach's alpha if item deleted	Intra-class coefficient correlation
Perceived barriers			
C12	0.2220	0.7975	0.89
C16	0.4240	0.7738	0.78
C17	0.5635	0.7565	0.92
C19	0.4076	0.7758	0.90
C21	0.3471	0.7830	0.79
C22	0.4758	0.7675	0.91
C24	0.3613	0.7814	0.79
C25	0.4223	0.7741	0.90
C26	0.6492	0.7455	0.92
C27	0.7312	0.7347	0.93

4.1.3.3 Health literacy questionnaire

Table 4.6 shows the internal consistency and test-retest reliability of the HLQ. This questionnaire addressed three domains, namely functional, communicative and critical HL. All three of these domains had good within-domain correlation as their corrected item-total score correlation values ranged from 0.3337 to 0.7130, 0.6916 to 0.8398 and 0.8216 to 0.8768, respectively. Also, the Cronbach's alpha for functional, communicative and critical HL was 0.7867, 0.9189 and 0.9330, respectively, which indicated good consistency (Gliner, 2000). Moreover, the ICC for functional, communicative and critical HL ranged from 0.60 to 0.89, which showed moderate to good reliability (De Vet et al., 2011).

Table 4.6: Internal Consistency and Test-Retest Reliability Results for the Health Literacy Questionnaire

Domain and items	Corrected item-total score correlation	Cronbach's alpha if item deleted	Overall Cronbach's alpha	Intra-class coefficient correlation
Functional				
D01	0.3337	0.8178	0.7867	0.82
D02	0.7130	0.6959		0.83
D03	0.7059	0.6984		0.79
D04	0.5874	0.7389		0.80
D05	0.5059	0.7654		0.69
Communicative				
D06	0.6916	0.9201	0.9189	0.85
D07	0.8398	0.8906		0.87
D08	0.8380	0.8910		0.88
D09	0.7893	0.9009		0.87
D10	0.7974	0.8992		0.86
Critical				
D11	0.8357	0.9147	0.9330	0.88
D12	0.8768	0.9012		0.88
D13	0.8345	0.9151		0.89
D14	0.8216	0.9192		0.89

4.1.4 Summary of Phase 1 Study

From the results of testing, the KQ, BDQ and HLQ seemed to be feasible, valid and reliable for measuring the level of knowledge, behaviour and HL related to influenza vaccination among HCWs. It was therefore considered that the measure could be used in the Phase 2 study to undertake a comprehensive evaluation of the factors associated with influenza vaccination among HCWs.

4.2 Phase 2: Factors associated with the uptake of influenza vaccination and the effectiveness of the influenza vaccination among healthcare workers

4.2.1 Missing data analysis

Among the 800 participants who consented to participate in the Phase 2 study, 20 (2.5%) had at least one missing data and five duplicates (0.6%). Variables with the most missing value were communicative and critical health literacy. Gender, ethnicity, job category and knowledge had complete data.

The p-value of Little's chi-square for this study was 0.3315, which indicated that the missing data were MCAR. Hence the method used to deal with this missing data was complete case analysis, where the analysis only included participants with complete data. Table 4.7 shows the missing values for each variable.

Table 4.7: Missing Values for Each Variable

Variable	n	Missing (n)
Sociodemographic characteristics		
Age	798	2
Gender	800	0
Ethnicity	800	0
Religion	799	1
Education	799	1
Job category	800	0
Department	799	1
Monthly income	799	1
Marital status	799	1
Living with a person aged >65 years	799	1
Living with a child aged <2 years	799	1
Living with a person with a chronic disease	799	1
Living with a pregnant woman	799	1
Chronic disease	798	2
Smoking	799	1
Knowledge	800	0
Behavioural determinants		
Perceived susceptibility	799	1
Perceived severity	800	0
Perceived benefits	800	0
Perceived barriers	795	5
Social influence	796	4
Motivating factors	795	5
Attitude	796	4
Self-efficacy	796	4
Health literacy		
Functional health literacy	793	6
Communicative health literacy	793	7
Critical health literacy	793	7
Absenteeism	797	3

4.2.2 Characteristics of the study population

4.2.2.1 Response rate

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: 388 from Hospital Taiping (response rate = 97%) and 412 from HRPB (response rate = 58.9%). Hospital Taiping had a good response rate because the nursing leaders gave a high level of commitment to helping researcher distribute and collect the questionnaires. Out of the 800 who returned the questionnaires, 775 were completed questionnaires that were subjected to analysis.

4.2.2.2 Characteristics of respondents and non-respondents

Table 4.8 shows the characteristics of respondents and non-respondents of the questionnaire surveyin phase 2. Data analysis showed there were no differences between the respondent and the non-respondent based on their gender, ethnicity and job categories.

Table 4.8: Characteristic of respondents vs non-respondents of questionnaire survey (N=1100)

Variable	Non response n=300 n (%)	Response n= 800 n (%)	P value
Gender			
Male	32 (10.7)	67 (8.4)	0.237
Female	268 (89.3)	733 (91.6)	
Ethnicity			
Malay	255 (85.0)	705 (88.1)	0.166
Non-Malay	45 (15.0)	95 (11.9)	
Job categories			
Assistant medical officer	28 (9.3)	46 (5.8)	0.165
Sister	30 (10.0)	73 (9.1)	
Community nurse	30 (10.0)	93 (11.6)	
Staff nurse	212 (70.7)	588 (73.5)	

4.2.2.3 Sociodemographic characteristics of the study population

The mean age of the participants was 34.9 (±7.69) years. The majority (91.9%) were female. The participants were predominantly Malay (87.7%) and Muslim (88.0%). The participants held the following positions: sisters (8.8%), registered nurses (74.1%), community nurses (11.6%) and assistant medical officers (5.5%).

The majority (87.5%) had tertiary education. Most of the participants also had a middle income; 52% reported a monthly income of RM3001–RM5000. 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 Paediatric, 10.2% from orthopaedics, 5.2% from emergency and 2.8% from other departments. The participants were either married (79.7%), separated (0.3%), divorced (2.5%), widowed (0.5%) or single (17.0%). Table 4.9 summarizes the sociodemographic characteristic of the study participants

Table 4.9: Sociodemographic Characteristics of the Participants (N=775)

Variables	n	(%)
Age (years) ±SD	34.9	±7.69
Gender		
Male	63	8.1
Female	712	91.9
Ethnicity		
Malay	680	87.7
Chinese	7	0.9
Indian	80	10.3
Others	8	1.1
Education		
Secondary school	97	12.5
Tertiary	678	87.5
Religion		
Islam	682	88.0
Buddhism	9	1.2
Christianity	15	1.9
Hinduism	66	8.5
Others	3	0.4
Job category		
Sister	68	8.8
Registered nurse	574	74.1
Assistant medical officer	43	5.5
Community nurse	90	11.6
Department		
Medical	240	31.0
Surgical	101	13.0
Obstetrics & Gynaecology	163	21.0
Anaesthesiology	52	6.7
Paediatric	78	10.1
Orthopaedic	79	10.2
Emergency	40	5.2
Others	22	2.8
Monthly income		
<RM3000	325	41.9
RM3001–RM5000	403	52.0
>RM5001	47	6.1
Marital status		
Married	618	79.7
Separated	2	0.3
Divorced	19	2.5
Widowed	4	0.5
Single	132	17.0

4.2.3 Descriptive analysis of prevalence and factors associated with influenza vaccination uptake

4.2.3.1 Prevalence of influenza vaccination uptake

In this study, the prevalence of influenza vaccination uptake was defined as uptake from the period from 1st November 2016 until 31st December 2016. Based on the immunization records from public health unit in studied hospitals, the prevalence of influenza vaccination among HCWs was 25.5%.

(a) ***Prevalence of influenza vaccination according to age***

Analysis of the prevalence of influenza vaccination uptake across age groups showed that the prevalence decreased with increasing age (Figure 4.1). The highest prevalence was found among the age group of less than 29 years old (31.3%), and the lowest prevalence was found among the age group of over 55 years old (2.5%).

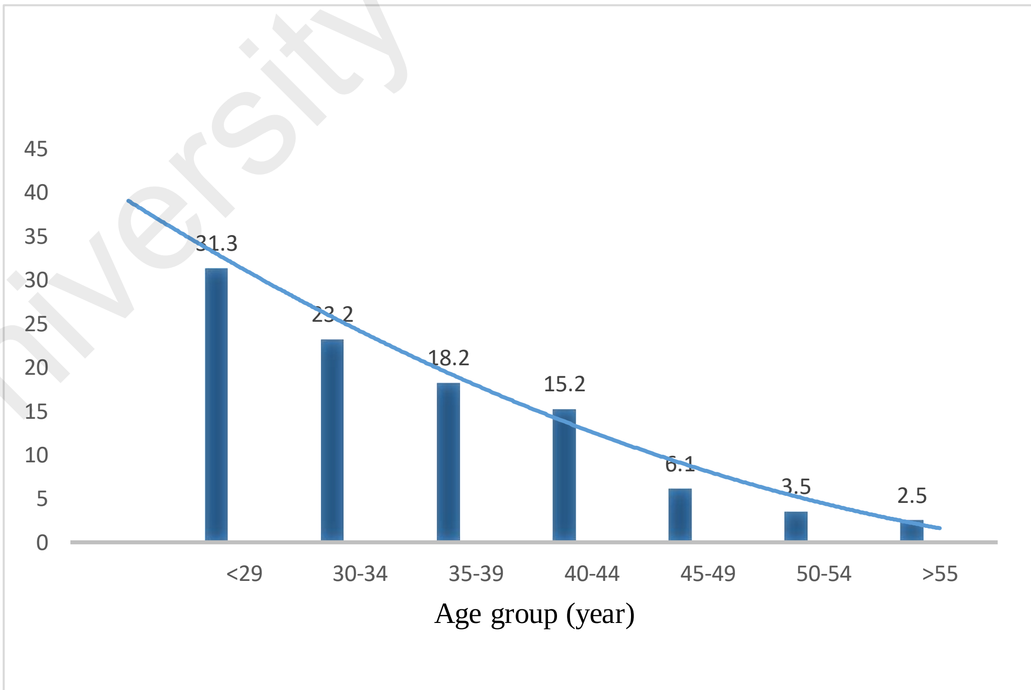

Figure 4.1: Percentage of influenza vaccination uptake among HCWs according to age group

(b) ***Prevalence of influenza vaccination uptake according to department***

The prevalence of influenza vaccination uptake was stratified according to the department. The uptake was highest among staff from the medical department (38%) followed by paediatric (15%), surgical (13%), emergency (10%), anaesthesiology (10%), orthopaedic (8%), O&G (5%) and other departments (1%). Figure 4.2 shows the percentage of influenza vaccination according to the department.

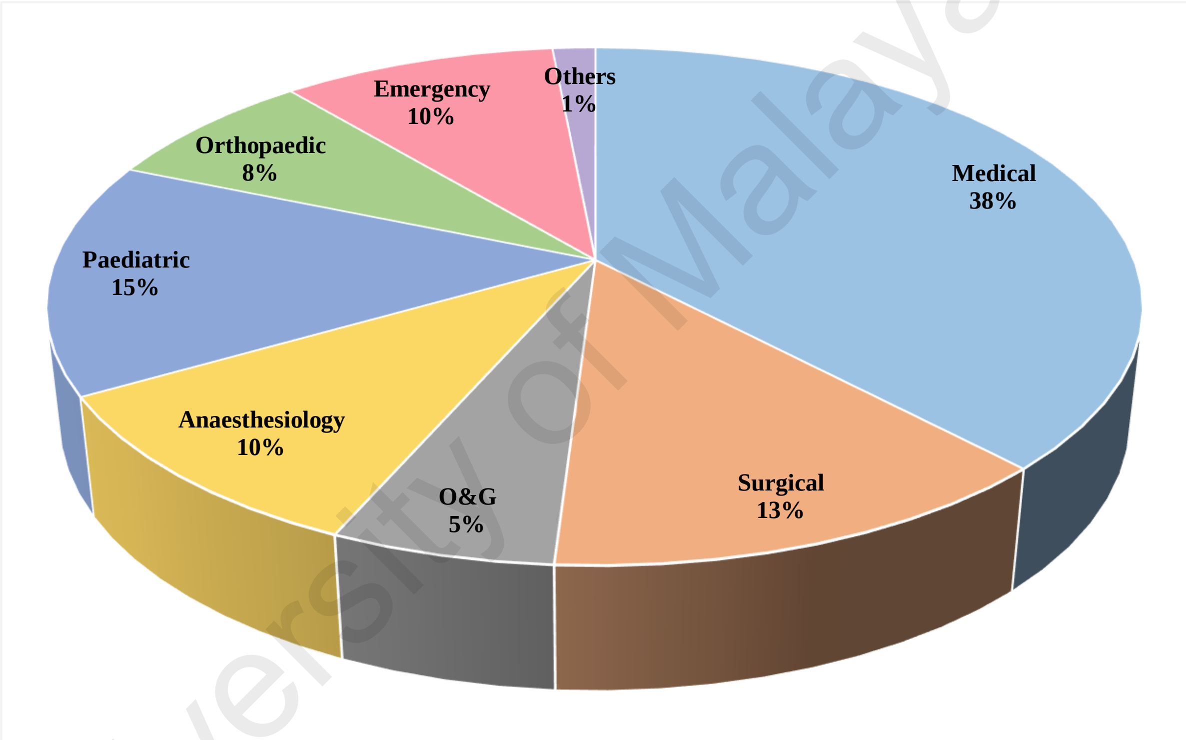

Figure 4.2: Percentage of influenza vaccination according to department

4.2.3.2 Sociodemographic characteristics

Table 4.10 shows the sociodemographic characteristics of the HCWs in relation to influenza vaccination uptake. The chi-square test showed that there was an association between vaccination uptake and department ($p < 0.001$). However, there was no association between vaccination uptake and age, gender, ethnicity, education, religion, job category, monthly income and marital status.

Table 4.10: Sociodemographic Characteristics According to Vaccination Uptake

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)	
Ethnicity			
Malay	508 (88.0)	172 (86.9)	0.664
Non-Malay	69 (12.0)	26 (13.1)	
Education			
Secondary school	76 (13.2)	21 (10.6)	0.347
Tertiary	501 (86.8)	177 (89.4)	
Religion			
Muslim	509 (88.2)	173 (87.4)	0.753
Non-Muslim	68 (11.8)	25 (12.6)	
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)	
Marital status			
Married	461 (79.9)	157 (79.3)	0.855
Non-married	116 (20.1)	41 (20.7)	

4.2.3.3 Need for influenza vaccination

In this study, the need for influenza vaccination was represented by the HCW living with a member of a high-risk group of developing influenza complications or the HCW having a chronic disease. Table 4.11 shows the need for an influenza vaccination according to the HCWs' vaccination status. It can be seen from the table that there was a low need for getting an influenza vaccination because most of the participants (>73%) were not living with a member of a high-risk group of getting influenza complications and more than 85% did not have an underlying chronic disease. The chi-square test showed that there was no significant difference in living with a high-risk group of getting influenza complications or the presence of chronic disease in the vaccinated and non-vaccinated group.

Table 4.11: Need for Influenza Vaccination According to Vaccination Uptake

Variable	Non-vaccinated N = 577 n (%)	Vaccinated N = 198 n (%)	P value
Living with a person aged >65 years			0.171
Yes	103 (17.8)	27 (13.6)	
No	474 (82.2)	171 (86.4)	
Living with a child aged <2 years			0.979
Yes	155 (26.9)	53 (26.8)	
No	422 (73.1)	145 (73.2)	
Living with a person with a chronic disease			0.696
Yes	28 (4.8)	11 (5.6)	
No	549 (95.2)	187 (94.4)	
Living with a pregnant woman			0.450
Yes	22 (3.8)	10 (5.0)	
No	555 (96.2)	188 (95.0)	
Present of chronic disease			
Yes	79 (13.7)	29 (14.6)	0.738
No	498 (86.3)	169 (85.4)	

4.2.3.4 Lifestyle behaviour

The lifestyle behaviour that we measured in this study was smoking status. According to the analysis, nearly all (99%) of the participants were non-smokers. Furthermore, there was no significant difference in smoking behaviour in both groups (non-vaccinated and vaccinated). Table 4.12 shows the smoking behaviour of the participants according to vaccination uptake.

Table 4.12: Lifestyle Behaviour (Smoking) according to Influenza Vaccination Uptake

Variable	Non-vaccinated N = 577 n (%)	Vaccinated N = 198 n (%)	P value
Smoking status [a]			
Smoking	25 (0.4)	1 (0.5)	0.5879
Not smoking	575 (99.6)	197 (99.5)	

[a] Fisher's exact test was used because the numbers in some cells were lower than five.

4.2.3.5 Knowledge

The mean knowledge score for seasonal influenza and vaccination was 4.96 ± 1.12 (range 2–8). Only 13 HCWs (1.7%) answered all eight questions correctly. The mean knowledge score was higher in males compared to females (5.10 ± 1.10 vs 4.94 ± 1.13). Among job categories, the mean score was highest among sisters (5.26 ± 1.02), followed by assistant medical officers (5.00 ± 1.20), staff nurses (4.93 ± 1.12) and community nurses (4.84). According to the department, the mean score was highest among those working in the emergency department (5.33) and lowest in the O&G department (4.67). The result showed that there was no statistically significant difference in the knowledge score by gender, education and job category (Table 4.13). However, one-way analysis of variance showed there was a significant difference at the $p < 0.05$ level in the mean knowledge score for the different departments [$F (7,767) = 3.69$, $p<0.001$). Post-hoc analysis using the Tukey test showed that there was a significant difference in the mean number of knowledge score between O&G and medical department (0.45 ±0.11, p=0.002) and O&G and emergency department (0.66 ± 0.20, p=0.021).

Table 4.13: HCWs score for Knowledge about Influenza and the Influenza Vaccine

Variable	Mean ± SD	P-value
Gender		0.3059[b]
Male	5.10 ± 1.10	
Female	4.94 ± 1.13	
Education		0.9803[b]
Secondary school	4.96 ± 1.19	
Tertiary	4.96 ± 1.12	
Job category		0.0976[a]
Sister	5.26 ± 1.02	
Staff nurse	4.93 ± 1.12	
Assistant medical officer	5.00 ± 1.20	
Community nurse	4.84 ± 1.15	
Department		**< 0.001[a]**
Medical	5.12 ± 1.10	
Surgical	4.79 ± 1.10	
Obstetrics & Gynaecology	4.67 ± 1.13	
Anaesthesiology	5.08 ± 1.28	
Paediatric	4.88 ± 0.99	
Orthopaedic	5.13 ± 1.11	
Emergency	5.33 ± 1.21	
Others	4.73 ± 0.88	

SD: standard deviation
[a] One-way analysis of variance
[b] T-test

Figure 4.3 shows that the mean score knowledge on influenza was higher in the vaccinated group compared to the non-vaccinated group for all departments except anaesthesiology.

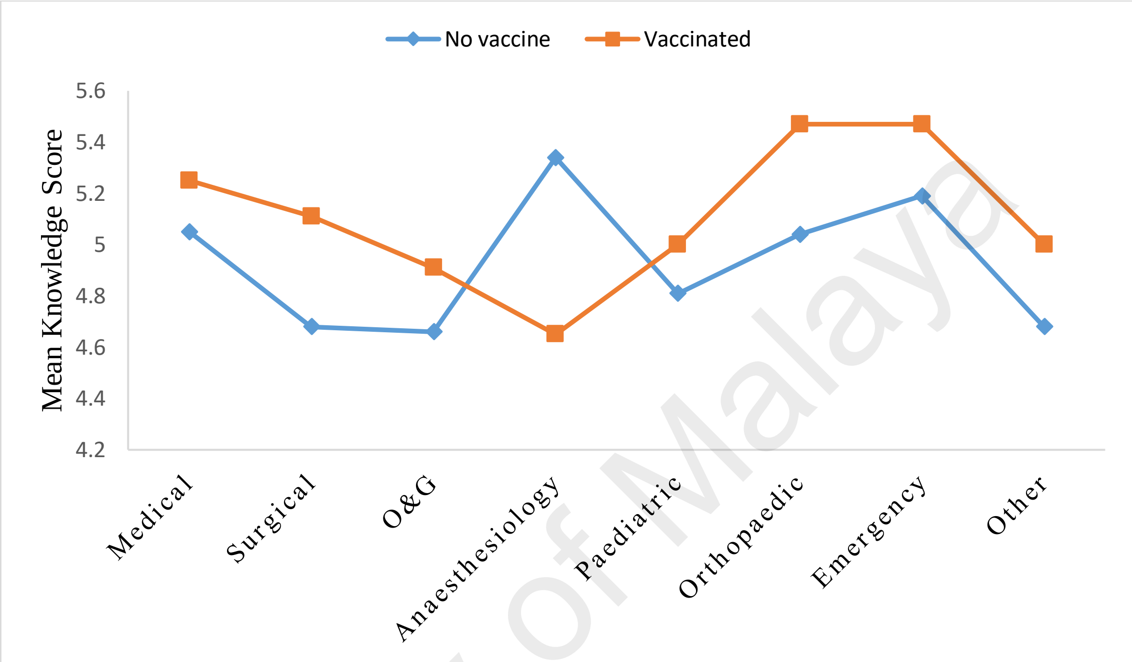

Figure 4.3: Mean knowledge score among HCWs according to department

As regards the HCWs' knowledge about influenza and influenza vaccination, it was revealed that 681 (87.9%) of HCWs believe that they are more susceptible to influenza infections than are other people and 740 (95.5%) believe that influenza is more serious than a common cold. With regards to the mode of transmission, 744 (96.0%) answered that influenza is transmitted primarily by coughing and sneezing while 388 (50.1%) responded that it is transmitted primarily by contact with body fluid. The majority (765, 98.7%) knew the signs and symptoms of influenza include fever, headache, sore throat, cough, nasal congestion, body aches and pains.

However, some misunderstandings were noticed. For instance, the participants had a poor understanding of how influenza vaccinations work, where 567 (73.2%) incorrectly disagreed with the statement Q6: "Influenza vaccination does not work in some persons, even if the vaccine has the right mix of viruses". Also, 569 (73.4%) of the HCWs were incorrectly agreed with the statement Q7: "Adults with influenza commonly experience nausea and vomiting or diarrhoea". Furthermore, and somewhat surprisingly, 666 (86%) of the respondents incorrectly answered that symptoms typically appear 8–10 days after a person is exposed to influenza (statement Q8). Table 4.14 shows the scores for each of the knowledge items.

Table 4.14: Knowledge of HCWs about Influenza and the Influenza Vaccine

No	Statement	Correct	Incorrect
Q1	Healthcare workers are less susceptible to influenza infections than are other people	681 (87.9%)	94 (12.1%)
Q2	Influenza is transmitted primarily by coughing and sneezing	744 (96.0%)	31 (4.0%)
Q3	Influenza is more serious than a common cold	740 (95.5%)	35 (4.5%)
Q4	The signs and symptoms of influenza include fever, headache, sore throat, cough, nasal congestion, and aches and pains	765 (98.7%)	10 (1.3%)
Q5	Influenza is transmitted primarily by contact with body fluid	388 (50.1%)	387 (49.9%)
Q6	Influenza vaccination does not work in some persons, even if the vaccine has the right mix of viruses	208 (26.8%)	567 (73.2%)
Q7	Adults with influenza commonly experience nausea and vomiting or diarrhoea	206 (26.6%)	569 (73.4%)
Q8	Symptoms typically appear 8–10 days after a person is exposed to influenza	109 (14.0%)	666 (86.0%)

Table 4.15 shows the percentage of HCWs who gave correct answers about influenza and the vaccination according to their influenza vaccination status. The table shows that there was a significant difference between the vaccinated and non-vaccinated groups in respect of two statements “Healthcare workers are less susceptible to influenza infections than other people” (p-value =0.043) and “Influenza vaccination does not work in some persons, even if the vaccine has the right mix of viruses” (p = 0.028). Overall, HCWs with a higher knowledge score were more likely to be vaccinated (p = 0.004).

Table 4.15: Knowledge about Influenza and the Influenza Vaccine according to Influenza Vaccination Uptake

No	Statement	Non-vaccinated N = 577 n (%)*	Vaccinated N = 198 n (%)*	P value
Q1	Healthcare workers are less susceptible to influenza infections than other people	499 (86.5)	182 (91.9)	**0.043**
Q2	Influenza is transmitted primarily by coughing and sneezing	555 (96.2)	189 (95.5)	0.650
Q3	Influenza is more serious than a common cold	547 (94.8)	193 (97.5)	0.118
Q4	The signs and symptoms of influenza include fever, headache, sore throat, cough, nasal congestion, and aches and pains	568 (98.4)	197 (99.5)	0.256
Q5	Influenza is transmitted primarily by contact with body fluid	279 (48.4)	109 (55.1)	0.104
Q6	Influenza vaccination does not work in some persons, even if the vaccine has the right mix of viruses	143 (24.8)	65 (32.8)	**0.028**
Q7	Adults with influenza commonly experience nausea and vomiting or diarrhoea	156 (27.0)	50 (25.3)	0.624
Q8	Symptoms typically appear 8–10 days after a person is exposed to influenza	74 (12.8)	35 (17.7)	0.090
	Total knowledge score, mean ± SD	4.89 ± 1.12	5.15 ± 1.12	**0.004**

*Percentage of HCWs who gave the correct answer

4.2.3.6 Behavioural determinants

Table 4.16 shows the scores of the participants who agreed or strongly agreed with the behaviour items according to their vaccination uptake. The results are presented in terms of median and range due to the non-normal distribution of the data. The table reveals that there was no difference in the median for all domains between the vaccinated and non-vaccinated groups.

However, notably, the median was in the higher range for all domains except for the perceived barriers domain. This indicates that the participants in both groups were highly influenced by perceived susceptibility, perceived severity, perceived benefits, social influence, motivating factors, attitude, and self-efficacy. Conversely, the influence of perceived barriers was low. The Mann–Whitney U test showed that there were no statistically significant differences in perceived susceptibility, perceived severity, perceived benefits, perceived barriers, social influence, motivating factors, attitude and self-efficacy between both groups.Univariate logistic regression showed similar results.

Table 4.16: Behavioural Determinants according to Influenza Vaccination Uptake

Behavioural determinant	Non-vaccinated Median (range)	Vaccinated Median (range)	Odds Ratio (95% CI)	P-value
Perceived susceptibility[a]	3.0 (0–4)	3.5 (0–4)	1.08 (0.94, 1.24)	0.285
Perceived severity[a]	3.9 (0–3)	3.9 (0–3)	0.86 (0.69, 1.06)	0.152
Perceived benefits[a]	4.0 (0–4)	4.0 (0–4)	1.10 (0.92, 1.30)	0.295
Perceived barriers[a]	1.0 (0–7)	1.0 (0–6)	1.03 (0.92, 1.16)	0.577
Social influence[a]	5.0 (0–5)	5.0 (0–5)	0.90 (0.78, 1.05)	0.165
Motivating factors[a]	4.0 (0–5)	4.0 (0–5)	0.99 (0.87, 1.14)	0.949
Attitude[a]	4.0 (0–4)	4.0 (0–4)	0.92 (0.76, 1.11)	0.362
Self–efficacy[a]	4.0 (0–5)	4.0 (0–5)	1.01 (0.90, 1.12)	0.876

[a] Data were not normally distributed, Mann–Whitney U test

4.2.3.7 Health literacy

Table 4.17 shows the level of HL among HCWs, where a mean score approaching 4 indicates a high level of HL and a mean score approaching 1 indicates a low level of HL. It can be seen that the HCWs scored best on functional HL, followed by critical and communicative HL. The mean score for each of the types of HL was higher among the vaccinated than among the non-vaccinated group.

The analysis revealed that the levels of functional HL and communicative HL were not significantly different between the vaccinated and non-vaccinated group (functional HL, p = 0.710, communicative HL p = 0.172). In contrast, the level of critical HL among the vaccinated group was significantly higher than among the non-vaccinated group (p = 0.049).

Table 4.17: Health Literacy according to Influenza Vaccination Uptake

Health literacy	**Non-vaccinated Mean ± SD**	**Vaccinated Mean ± SD**	**P-value**
Functional HL*	3.06 ± 0.73	3.08 ± 0.74	0.710
Communicative HL	2.72 ± 0.69	2.80 ± 0.58	0.172
Critical HL	2.99 ± 0.72	3.09 ± 0.70	**0.049**

SD: standard deviation
*Reverse scored for ease of interpretation

4.2.4 Association between risk factors and influenza vaccination uptake

4.2.4.1 Sociodemographic characteristics

Table 4.18 shows the result of the univariate logistic regression that was applied to sociodemographic characteristics and the uptake of the influenza vaccination. It is evident from the table that HCWs working in the medical (OR 1.52; 95% CI 0.13, 1.54), anaesthesiology (OR 1.91; 95% CI 1.07, 3.43), paediatric (OR 1.85; 95% 1.13, 3.02) or emergency department (OR 2.81; 95% CI 1.48, 5.35) had significant higher odds of having an influenza vaccination compared to those in other departments category when other confounders were not adjusted for.

In contrast, HCWs working in the O&G department had 0.16 times the odds of having the influenza vaccination compared to HCWs in other departments category (OR 0.16; 95% CI 0.09, 0.31; p-value < 0.001) when other confounders were not adjusted for.

Table 4.18: Association between Sociodemographic and Influenza Vaccination

Variables	Odds ratio (95% CI)	P-value
Age (years)	1.01 (0.99, 1.03)	0.401
Gender		
Male	1.0 (reference)	
Female	1.11 (0.61, 2.02)	0.741
Ethnicity		
Non-Malay	1.0 (reference)	
Malay	0.90 (0.55, 1.46)	0.664
Education		
Secondary school	1.0 (reference)	
Tertiary	1.28 (0.77, 2.13)	0.347
Religion		
Non-Muslim	1.0 (reference)	
Muslim	0.92 (0.57, 1.51)	0.753
Job category		
Assistant medical officer	1.0 (reference)	
Sister	0.89 (0.49, 1.59)	0.690
Community nurse	0.94 (0.56, 1.56)	0.798
Registered nurse	1.13 (0.78, 1.64)	0.529
Department		
Other departments	1.0 (reference)	
Medical	1.52 (0.13, 1.54)	**0.015**
Surgical	1.01 (1.08, 2.14)	0.962
Obstetrics & Gynaecology	0.16 (0.09, 0.31)	**<0.001**
Anaesthesiology	1.91 (1.07, 3.43)	**0.029**
Paediatric	1.85 (1.13, 3.02)	**0.014**
Orthopaedic	0.66 (0.37, 1.18)	0.161
Emergency	2.81 (1.48, 5.35)	**0.002**
Monthly income		
RM2001–RM3000	1.0 (reference)	
RM3001–RM5000	0.92(0.67, 1.27)	0.626
Marital status		
Non-married	1.0 (reference)	
Married	0.96 (0.65, 1.44)	0.855

CI: Confidence interval

4.2.4.2 Need for Influenza Vaccination

The univariate logistic regression that was conducted on vaccination need showed that there was no association between the living situation and chronic disease oneself of the HCWs and their uptake of the influenza vaccination (Table 4.19).

Table 4.19: Association between Vaccination Need and Influenza Vaccination

Variable	Odds Ratio (95% CI)	P value
Living situation		
Living with person > 65 years	0.73 (0.46, 1.15)	0.172
Living with child < 2 years	0.99 (0.69, 1.43)	0.979
Living with person with chronic disease	1.15 (0.56, 2.36)	0.696
Living with a pregnant woman	1.34 (0.62, 2.89)	0.452
Presence of chronic disease	0.92 (0.58, 1.46)	0.738

CI: Confidence interval

4.2.4.3 Lifestyle behaviour

The univariate logistic regression showed that there is no association between lifestyle behaviour (smoking status) of the HCWs and their uptake of the influenza vaccination (OR 0.69; 95% CI 0.06, 7.60; p= 0.758). The p value was difference from p value in table 4.11 due to different test was run.

4.2.4.4 Knowledge

The univariate logistic regression that was performed on the relation between knowledge and having an influenza vaccination revealed that a 1-point increase in knowledge score significantly increased 1.22 the odds of the HCW having an influenza vaccination when other confounders were not adjusted for (OR 1.22; 95% CI 1.06, 1.42; p value= 0.005).

4.2.4.5 Behavioural determinants

A further univariate logistic regression was conducted to determine whether there was an association between the items in behavioural determinants and vaccination uptake. The results presented in Table 4.16 show that there were no associations between any of the determinants and having the influenza vaccination.

Table 4.20 presents the percentage of participants who agreed or strongly agreed with the items in the BDQ according to vaccination uptake. In the social influence domain, the HCWs who agreed with the statement "My relatives believe that my vaccination is important" had significant odds of getting vaccinated when other confounders were not adjusted for (OR 0.60; 95% CI 0.42, 0.86).

Table 4.20: Association between Behavioural Determinants and Influenza Vaccination Uptake among Healthcare Workers

No.	Participants' opinion	Non-vaccinated (N = 577)[a] n (%)	Vaccinated (N = 198)[a] n (%)	Odds ratio (95% CI)	P-value
	Perceived susceptibility				
C01	I have a high risk of contracting influenza	498 (86.3)	168 (84.9)	0.89 (0.56, 1.40)	0.610
C02	I can spread infection to my patients even if I am asymptomatic	305 (52.9)	112 (56.6)	1.16 (0.84, 1.61)	0.367
C03	Health professionals are under the highest risk in case of an epidemic	517 (89.6)	190 (96.0)	1.46 (0.74, 2.87)	0.274
C04	I can spread the infection to my family even if I am asymptomatic	354 (61.4)	125 (63.1)	1.08 (0.77, 1.50)	0.657
	Perceived severity				
C05	Influenza is dangerous for me	527 (91.3)	177 (89.4)	0.80 (0.47, 1.37)	0.415
C06	Influenza is dangerous for my patients	542 (93.9)	180 (90.9)	0.65 (0.36, 1.17)	0.148
C07	Influenza is dangerous for my family members	550 (95.3)	182 (91.9)	0.56 (0.29, 1.06)	0.075
	Perceived benefits				
C08	Vaccination reduces my personal risk of influenza	527 (91.3)	186 (93.9)	1.47 (0.77, 2.82)	0.246
C09	Vaccination reduces the risk of spreading the disease to my patients	512 (88.7)	183 (92.4)	1.55 (0.86, 2.78)	0.144
C10	Vaccination reduces the risk of spreading the disease to my family members	517 (89.6)	180 (90.9)	1.16 (0.67, 2.02)	0.598
C11	Community vaccination reduces my workload during an outbreak	382 (66.2)	133 (67.2)	1.04 (0.74, 1.47)	0.804
	Perceived barriers				
C12	I expect a side effect after vaccination*	63 (10.9)	29 (14.6)	1.40 (0.87, 2.24)	0.163
C13	I am against vaccination*	17 (2.9)	3 (1.5)	0.5 (0.15, 1.75)	0.282

"Continued"

Table 4.20: Association between Behavioural Determinants and Influenza Vaccination Uptake among Healthcare Workers

No	Participants' opinion	Non-vaccinated (N = 577)[a] n (%)	Vaccinated (N = 198)[a] n (%)	Odds ratio (95% CI)	P-value
C14	The need for vaccination every year negatively affects my regular vaccination schedule	85 (14.7)	23 (11.6)	0.76 (0.47, 1.24)	0.276
C15	I had or I knew someone who had side effects from previous influenza vaccinations	197 (34.1)	79 (39.9)	1.28 (0.92, 1.79)	0.145
C16	Healthcare workers should NOT be vaccinated even if patients have been vaccinated*	18 (3.1)	7 (3.5)	1.13 (0.47, 2.77)	0.775
C17	I find an injection every year uncomfortable	124 (21.5)	31 (15.7)	0.68 (0.44, 1.04)	0.078
C18	I believe the vaccines are NOT useful*	9 (1.56)	0 (0)	-	-
C19	I believe in alternative medicine	175 (30.3)	73 (36.87)	1.34 (0.96, 1.88)	0.089
C20	I believe that natural methods are better than vaccination	67 (11.6)	27 (13.6)	1.20 (0.74, 1.94)	0.452
C21	I am against vaccination due to my beliefs	31 (5.37)	10 (5.1)	0.94 (0.45, 1.95)	0.861
	Motivating factors				
C22	I know the Ministry of Health recommendations about influenza vaccination	537 (93.0)	190 (96.0)	1.77 (0.81, 3.85)	0.150
C23	I know the Ministry of Health recommendations about the age groups and chronic diseases which require influenza vaccination	501 (86.8)	171 (86.4)	0.96 (0.60, 1.54)	0.868
C24	I have sufficient knowledge about influenza	286 (49.6)	96 (48.5)	0.96 (0.69, 1.32)	0.793
C25	I get knowledge about influenza from reliable sources every year	463 (80.2)	160 (80.8)	1.04 (0.69, 1.56)	0.863
C26	The Ministry of Health provides free vaccination for healthcare workers	542 (93.9)	181 (91.4)	0.69 (0.38, 1.26)	0.224
	Social influence				
C27	My relatives believe that my vaccination is important	458 (79.4)	138 (69.7)	0.60 (0.42, 0.86)	**0.006**
C28	My workplace organization recommends my vaccination	539 (93.4)	183 (92.4)	0.86 (0.46, 1.60)	0.634

“Continued”

Table 4.20: Association between Behavioural Determinants and Influenza Vaccination Uptake among Healthcare Workers

No	Participants’ opinion	Non-vaccinated (N = 577) [a] n (%)	Vaccinated (N = 198) [a] n (%)	Odds ratio (95% CI)	P-value
C29	My colleagues believe that my vaccination is important	533 (92.3)	182 (91.9)	0.94 (0.52, 1.70)	0.836
C30	The healthcare providers recommend vaccination (e.g., doctor, nurse)	546 (94.6)	188 (95.0)	1,07 (0.51, 2.22)	0.861
C31	The Ministry of Health recommends vaccination for healthcare workers	557 (96.5)	190 (96.0)	0.85 (0.37, 2.00)	0.709
	Attitude				
C32	I feel it is important that healthcare workers do not spread the disease to their patients	509 (88.2)	168 (84.9)	0.75 (0.47, 1.19)	0.220
C33	I believe that healthcare workers should be vaccinated for the continuity of health services	548 (95.0)	186 (94.0)	0.82 (0.41, 1.64)	0.575
C34	Healthcare workers themselves (as users) should have the right to choose to be vaccinated	442 (76.6)	139 (70.2)	0.72 (0.50, 1.03)	0.074
C35	Influenza vaccination should be mandatory for healthcare workers	472 (81.8)	171 (86.4)	1.41 (0.89, 2.23)	0.142
	Self-efficacy				
C36	I would be vaccinated every year if I had enough time	427 (74.0)	142 (71.7)	0.89 (0.62, 1.28)	0.530
C37	I would be vaccinated if someone reminded me	366 (63.4)	136 (68.7)	1.26 (0.90, 1.79)	0.182
C38	I would be vaccinated every year if the vaccination were provided by my organization	485 (84.1)	169 (85.4)	1.11 (0.70, 1.74)	0.664
C39	I would be vaccinated every year if I were rewarded	163 (28.2)	55 (27.7)	0.98 (0.69, 1.40)	0.899
C40	I would be vaccinated every year if I were given sufficient knowledge	416 (72.1)	139 (70.2)	0.91 (0.64, 1.30)	0.610

CI: Confidence interval

[a] Number of participants who agreed or strongly agreed/total number of responses (percentage of strongly agreeing or agreeing)

* Reverse coded for ease of interpretation

4.2.4.6 Health literacy

The univariate logistic regression that was applied to the HL domains revealed that functional HL, communicative HL and critical HL had no association with influenza vaccination uptake (Table 4.21).

Table 4.21: Association between Health Literacy and Influenza Vaccination

Variable	Odds Ratio (95% CI)	P-value
Functional HL	1.03 (0.82, 1.30)	0.779
Communicative HL	1.18 (0.92, 1.51)	0.188
Critical HL	1.22 (0.97, 1.54)	0.093

CI: Confidence interval

Table 4.22 shows the univariate logistic regression for each HL item. The results show that an increase of 1 point in the score for the statement D08 "Did you understand the obtained information on influenza vaccines" led to 1.37 odds of getting an influenza vaccination in the vaccinated group as compared to the non-vaccinated group (OR 1.37, 95% CI 1.10, 1.71; p value= 0.005). Also, an increase of 1 point in the score for the statement D11 "Did you consider whether the information was applicable to your situation" resulted in 1.24 odds of getting an influenza vaccination in the vaccinated group as compared to the non-vaccinated group (OR 1.24; 95% CI 1.01, 1.53; p-value 0.044) when other confounders were not adjusted for.

Table 4.22: Association between Health Literacy and Influenza Vaccination among Healthcare Workers

No	Participants' opinion	Non-vaccinated (N = 577) Median (IQR)	Vaccinated (N = 198) Median (IQR)	Odds Ratio (95% CI)	P-value
	Functional health literacy[a]				
D01	Did you find the print too small to read?	3 (1)	3 (2)	1.07 (0.88, 1.30)	0.450
D02	Did you find the characters and words that you do not understand?	3 (2)	3(2)	0.99 (0.82, 1.20)	0.963
D03	Did you find the text was too difficult to read?	3 (2)	3 (2)	1.03 (0.85, 1.25)	0.746
D04	Did you need a long time to read and understand the text?	3 (2)	3 (2)	1.06 (0.88, 1.28)	0.504
D05	Did you need someone to help you read them?	4 (1)	4 (1)	0.94 (0.77, 1.14)	0.543
	Communicative Health literacy[a]				
D06	Did you collect information on influenza vaccination from various sources?	3 (1)	3 (1)	1.13 (0.94, 1.36)	0.187
D07	Did you looked for the information you wanted?	3 (1)	3 (1)	0.94 (0.77, 1.15)	0.530
D08	Did you understand the obtained information on influenza vaccines?	3 (1)	3 (1)	1.37 (1.10, 1.71)	**0.005**
D09	Did you communicate your thoughts about influenza vaccination to someone?	3 (1)	3 (1)	1.06 (0.87, 1.28)	0.584
D10	Did you apply the obtained information to make decisions regarding your influenza vaccination?	3 (1)	3 (1)	1.14 (0.94, 1.37)	0.186
	Critical Health literacy[a]				
D11	Did you consider whether the information was applicable to your situation?	3 (1)	3 (1)	1.24 (1.01, 1.53)	**0.044**
D12	Did you consider the credibility of the information about influenza vaccine?	3 (1)	3 (1)	1.18 (0.96, 1.46)	0.115
D13	Did you check whether the information about influenza vaccines was correct?	3 (1)	3 (1)	1.14 (0.94, 1.39)	0.191
D14	Did you collect information to make decisions about influenza vaccination for yourself?	3 (2)	3 (0)	1.11 (0.91, 1.35)	0.292

CI: Confidence interval; IQR: Interquartile range
[a] Data not normally distributed

4.2.5 Multivariate logistic regression analysis

In this study, we also performed a multivariate logistic regression to determine the factors associated with influenza vaccination uptake among HCWs. The multivariable model was used to find the best model fit considering the model, which was biologically plausible, parsimonious and has the best fit.

MODEL 1 was adjusted for sociodemographic variables. The area under the receiver operating (ROC) curve was 0.7159 indicated MODEL 1 correctly predicted 71.59% of HCW influenza vaccination in this study. MODEL 2 was adjusted for sociodemographic, and knowledge variables showed the area under the ROC curve of 0.7170. MODEL 3 was adjusted for sociodemographic, knowledge and behavioural variables with the area under the ROC curve of 0.7303.

Finally, MODEL 4 was a fully adjusted model where the model was adjusted for sociodemographic, knowledge, behavioural and HL variables showed the highest area under the ROC curve of 0.7332 indicated MODEL 4 correctly predicted 73.3% of HCW influenza vaccination in this study. As for MODEL 4, both stepwise forward and stepwise backward logistic regression methods give the same results in term of odd ratio and coefficient value. The variables which were significant in the model were age, working as a community nurse, working in O&G department and emergency department.

As illustrated in Table 4.23, the fully adjusted model (MODEL 4) depicted that with a 1-year increase in the age, a HCW had 1.04 times the odds of getting an influenza vaccination (aOR 1.04; 95% CI 1.01, 1.08; p-value 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-value 0.024).

In addition, it showed that a HCW working in an O&G department had 0.17 times the odds of getting an influenza vaccination compared to working in other departments group (aOR 0.17; 95% CI 0.04, 0.85; p-value 0.003). Lastly, the model depicted 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-value 0.016).

Table 4.23: Multiple Logistic Regression on Factors Associated with Influenza Vaccination Uptake among Healthcare Workers

Variables	MODEL 1 aOR (95% CI)	P-value	MODEL 2 aOR (95% CI)	P-value	MODEL 3 aOR (95% CI)	P - value	MODEL 4 aOR (95% CI)	P-value
Age	1.04 (1.01, 1.07)	**0.025**	1.04 (1.01, 1.07)	**0.020**	1.04 (1.01, 1.08)	**0.015**	1.04 (1.01, 1.08)	**0.015**
Gender								
Male	1.0		1.0		1.0		1.0	
Female	1.48 (0.55, 4.00)	0.439	1.49 (0.55, 4.03)	0.435	1.58 (0.57, 4.40)	0.377	2.23 (0.70, 7.14)	0.176
Race								
Non-Malay	1.0		1.0		1.0		1.0	
Malay	0.32 (0.02, 5.47)	0.429	0.37 (0.02, 6.37)	0.493	0.38 (0.02, 7.03)	0.522	0.43 (0.02, 7.93)	0.569
Education								
Secondary school	1.0		1.0		1.0		1.0	
Tertiary	1.86 (0.62, 5.60)	0.273	2.00 (0.65, 6.14)	0.223	2.2 (0.71, 6.87)	0.169	2.09 (0.65, 6.70)	0.215
Religion								
Non-Muslim	1.0		1.0		1.0		1.0	
Muslim	2.12(0.12, 39.38)	0.598	1.92 (0.11, 34.72)	0.659	1.86 (0.10, 35.33)	0.680	1.71 (0.09, 33.30)	0.724
Job category								
Assistant medical officer	1.0		1.0		1.0		1.0	
Sister	1.16 (0.28, 4.83)	0.836	1.10 (0.26, 4.58)	0.899	1.11 (0.26, 4.75)	0.891	0.86 (0.18, 4.09)	0.851
Community Nurse	9.97(1.76, 56.60)	**0.009**	9.93(1.72, 56.98)	**0.010**	12.51 (2.11,74.08)	**0.005**	8.48 (1.33, 54.0)	**0.024**
Registered Nurse	2.50(0.70, 8.90)	0.159	2.43 (0.68, 8.70)	0.174	2.63 (0.71, 9.66)	0.146	1.88(0.47, 7.49)	0.373

"Continued"

Table 4.23: Multiple Logistic Regression on Factors Associated with Influenza Vaccination Uptake among Healthcare Workers

Variables	MODEL 1 aOR (95% CI)	P-value	MODEL 2 aOR (95% CI)	P-value	MODEL 3 aOR (95% CI)	P-value	MODEL 4 aOR (95% CI)	P-value
Departments								
Other departments	1.0		1.0		1.0		1.0	
Medical	2.70 (0.74, 9.90)	0.133	2.58(0.71, 9.45)	0.152	2.7 (0.73, 10.03)	0.137	1.77 (0.42, 7.52)	0.437
Surgical	1.99 (0.52, 7.65)	0.317	1.99 (0.52, 7.62)	0.318	2.1 (0.55, 8.25)	0.276	1.35 (0.31, 5.97)	0.688
O&G	0.24(0.06, 1.03)	0.054	0.24(0.06, 1.04)	0.056	0.27 (0.06, 1.17)	0.080	0.17 (0.04, 0.85)	**0.003**
Anaesthesiology	3.75 (0.93, 15.05)	0.063	3.61 (0.90, 14.48)	0.070	4.09 (1.00, 16.74)	0.050	2.51(0.54, 11.75)	0.241
Paediatric	2.33 (0.59, 9.25)	0.229	2.31 (0.58, 9.17)	0.232	2.42 (0.60, 9.72)	0.211	1.43 (0.31, 6.55)	0.640
Orthopaedic	1.22 (0.30, 4.89)	0.778	1.16 (0.29, 4.65)	0.836	1.21 (0.30, 4.92)	0.793	0.79 (1.71, 3.67)	0.766
Emergency	9.77 (2.24, 42.56)	**0.002**	8.93(2.05, 38.97)	**0.004**	9.99 (2.24, 44.70)	**0.003**	7.20 (1.45, 35.69)	**0.016**
Monthly income								
RM2001–RM3000	1.0		1.0		1.0		1.0	
RM3001–RM5000	0.90(0.58, 1.38)	0.639	0.88 (0.57, 1.36)	0.578	0.94 (0.60, 1.46)	0.772	0.95 (0.59, 1.53)	0.836
>RM5000	1.45(0.59, 3.57)	0.414	1.38 (0.56, 3.41)	0.484	1.50 (0.60, 3.76)	0.389	1.36 (0.51, 3.63)	0.533
Marital status								
Non-married	1.0		1.0		1.0		1.0	
Married	0.87(0.55, 1.39)	0.572	0.88 (0.55,1.40)	0.591	0.85(0.53, 1.36)	0.500	0.85 (0.52, 1.40)	0.528

“Continued”

Table 4.23: Multiple Logistic Regression on Factors Associated with Influenza Vaccination Uptake among Healthcare Workers

Variables	**MODEL 1 aOR (95% CI)**	**P-value**	**MODEL 2 aOR (95% CI)**	**P-value**	**MODEL 3 aOR (95% CI)**	**P-value**	**MODEL 4 aOR (95% CI)**	**P-value**
Living situation								
Living with person >65 years	0.63(0.38, 1.06)	0.084	0.64 (0.38,1.08)	0.098	0.65 (0.38, 1.11)	0.115	0.63 (0.34, 1.10)	0.105
Living with child <2 years	0.99(0.65, 1.51)	0.955	1.01 (0.66,1.54)	0.958	1.01 (0.65, 1.55)	0.982	1.09 (0.69, 1.73)	0.698
Living with person with chronic disease	0.966 (0.44, 2.20)	0.932	0.95 (0.43,2.11)	0.906	0.91 (0.40, 2.04)	0.812	1.28 (0.53, 3.08)	0.577
Living with pregnant woman	1.45 (0.64, 3.29)	0.375	1.37(0.60,3.12)	0.453	1.40 (0.61, 3.22)	0.431	1.14 (0.43, 3.00)	0.791
Chronic Disease								
No	1.0		1.0		1.0		1.0	
Yes	0.90 (0.52, 1.54)	0.698	0.90 (0.52, 1.54)	0.698	0.90 (0.52,1.54)	0.691	0.89 (0.50, 1.60)	0.707
Smoking status								
Smoking	1.0		1.0		1.0		1.0	
Non-smoking	0.46 (0.03, 6.21)	0.559	0.47(0.04, 6.25)	0.565	0.59 (0.04, 9.13)	0.707	0.95 (0.53, 1.72)	0.875
Knowledge	-	-	1.14 (0.97,1.33)	0.109	1.17 (0.99, 1.38)	0.053	1.19 (0.99, 1.42)	0.050
Behavioural determinants	-	-	-	-				
Perceived susceptibility	-	-	-	-	1.12 (0.94,1.31)	0.238	1.12 (0.94, 1.35)	0.209
Perceived severity	-	-	-	-	0.78 (0.60, 1.02)	0.067	0.78 (0.58, 1.05)	0.102

"Continued"

Table 4.23: Multiple Logistic Regression on Factors Associated with Influenza Vaccination Uptake among Healthcare Workers

Variables	MODEL 1 aOR (95% CI)	P-value	MODEL 2 aOR (95% CI)	P-value	MODEL 3 aOR (95% CI)	P-value	MODEL 4 aOR (95% CI)	P-value
Perceived Benefits	-		-	-	1.16 (0.95, 1.42)	0.150	1.13(0.90, 1.40)	0.284
Perceived Barriers	-		-	-	1.00 (0.88, 1.14)	0.970	0.97 (0.84, 1.12)	0.686
Social influence	-		-	-	0.86 (0.70, 1.07)	0.178	0.83(0.65, 1.04)	0.111
Motivating factors	-		-	-	1.02 (0.85, 1.22)	0.871	1.05 (0.85, 1.28)	0.648
Attitude	-		-	-	0.91 (0.72, 1.17)	0.476	0.88 (0.67, 1.14)	0.356
Self-efficacy			-	-	1.01 (0.89, 1.15)	0.850	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
Area under the receiver operating (ROC) curve	0.7159		0.7170		0.7303		0.7332	

aOR: Adjusted Odds ratio
CI: Confidence interval
MODEL 1 adjusted for sociodemographic variables
MODEL 2 adjusted for sociodemographic and knowledge variables
MODEL 3 adjusted for sociodemographic, knowledge and behavioural variables
MODEL 4 fully adjusted model; adjusted for sociodemographic, knowledge, behavioural and health literacy variables

4.2.5.1 Interaction and multicollinearity in the model

The final model was checked for interaction and multicollinearity. The possible interaction terms were created based on the practical consideration, and they were added one at a time into the model. The interaction terms generated were age*community nurse, community nurse*O&G, community nurses*emergency. The results showed that the interaction terms were not significant ($p > 0.05$) and the collinearity was relatively small.

4.2.5.2 The goodness of fit of the model

Table 4.24 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 factors associated with 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, methods to evaluate the goodness of fit of the logistic regression model include Hosmer and Lemeshow test, classification table and receiver operating characteristics (ROC) curve analysis (Hosmer et al, 2013). 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 (Hosmer et al, 2013). The model also correctly classified 74.45% of the respondents. According to Hosmer et al. (2013) area under the ROC curve of more than 0.7 is considered acceptable discrimination. However, the area under the ROC curve for the model in this study was 0.6417, which meant that the model was able to discriminate only 64.17% of the cases accurately. 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 4.24: 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

SE: Standard error
CI: Confidence interval

4.2.6 Effectiveness of influenza vaccination on absenteeism

Table 4.25 shows that out of the 774 participants, 136 (17.6%) reported taking influenza-related sick leave in the past 12 months in 2017. Sick leave was reported more often by non-vaccinated HCWs (18.1%, mean 0.39 ±1.03) than by vaccinated HCWs (16.2%, mean 0.27 ± 0.75) with an excess of 0.12 of mean days lost was recorded in unvaccinated HCWs. However, the difference was found not to be statistically significant (p=0.388).

Table 4.25: Sick Leave Taken by Healthcare Workers in 12-Month Period (N=774*)

	Non-vaccinated N (%/ SD) (n=576)	Vaccinated N (%/ SD) (n=198)	Total	P value
Number of HCWs who did not take any influenza-related sick leave in the past 12 months (%)	472 (81.9)	166 (83.8)	638 (82.4)	-
Number of HCWs who reported taking influenza-related sick leave in the past 12 months (%)	104 (18.1)	32 (16.2)	136 (17.6)	0.546
Mean number of cumulative sick leave days per person, mean (±SD)	0.39 (±1.03)	0.27 (±0.75)	-	-
Mean difference of cumulative sick leave days per person	+ 0.12	-	-	0.388

*1 participant with sick leave not due to influenza was excluded from the analysis

Table 4.26 shows the distribution of reported sick leave. The sick leave ranged from 1 to 12 days per employee. The total workdays lost due to influenza was 225 days/ year among non-vaccinated HCWs and 53 days/year among the vaccinated HCWs in the studied hospitals.

Table 4.26: Distribution of reported sick leave

Number of sick leave days per employee	Non-vaccinated n (%)	Total work days lost	Vaccinated n (%)	Total work days lost
0	472 (81.9)	0	166 (83.8)	0
1	35 (6.1)	35	19 (9.6)	19
2	39 (6.8)	78	9 (5.6)	18
3	21 (3.6)	63	2 (1.0)	6
4	5 (0.9)	20	1 (0.5)	4
5	2 (0.3)	10	0 (0.0)	0
6	0 (0.0)	0	1 (0.5)	6
7	1 (0.2)	7	0 (0.0)	0
12	1 (0.2)	12	0 (0.0)	0
Total	576 (100)	225	198 (100)	53

However, notably, the total number of workdays lost due to influenza among non-vaccinated HCWs was 1.44 times higher than that among the vaccinated group in the studied hospitals (39 days/100 subjects in the non-vaccinated group vs 27 days/100 subjects in the vaccinated group) (Table 4.27). Based on the formula for vaccine effectiveness that has been discussed in 3.2.9.17 in Chapter 3 (Abu H Samad et al., 2006), therefore the vaccine effectiveness was calculated to be 30.8 %.

Table 4.27 Effectiveness of the influenza vaccination on work absenteeism

	Rate per 100 subjects		
Study outcome	**Non vaccinated group**	**Vaccinated group**	**Vaccine effectiveness (%)**
Total workday lost in the 12 months	39	27	30.8

4.3 Chapter Summary

This chapter presented the detailed results of Phase 1 and Phase 2 studies. First, it described how, in Phase 1, the Bahasa Melayu version of the KQ was revised from 11 to eight items, and the BDQ was revised from 46 to 40 items, whereas the 14 items in the HLQ were retained. This meant that nine items in total were removed from the KQ, BDQ and HLQ due to poor correlation. Overall, the final version of the questionnaire displayed good psychometric properties in terms of the KR20 formula and Cronbach's alpha as well as good test-retest reliability in measuring the factors associated with influenza vaccination among HCWs.

The chapter also reported on the results of analysing the data obtained in Phase 2 of the study in which the validated questionnaire was administered in two selected hospitals in Perak. The data analysis revealed that the majority of the participants were female, Malay, Muslim, registered nurses, had tertiary education and a middle monthly income. The data also showed that the prevalence of influenza vaccination was low at 25.5%. The final multiple logistic regression model, which was shown to have a good fit, indicated that the odds of HCWs having an influenza vaccination increased with increasing age, being a community nurse and working in the emergency department. The model also showed that working in the O&G department reduced the odds of having influenza vaccination. Further analysis revealed that there was no mean difference in work absenteeism between the vaccinated and non-vaccinated groups of HCWs. However, the total number of workdays lost among non-vaccinated HCWs was 1.44 times higher than among the vaccinated group in a 12-month period with vaccine effectiveness was calculated to be 30.8 %.

CHAPTER 5: DISCUSSION

About the chapter

This chapter will discuss the findings pertaining to the validation of the knowledge (KQ), behavioural determinants (BDQ) and health literacy questionnaire (HLQ), prevalence, factors associated with of the influenza vaccination uptake and the effectiveness of the influenza vaccination on absenteeism among HCWs. The results are compared with previous findings. The strengths, limitations and implications of the study are also discussed in this chapter.

5.1 Phase 1: The psychometric assessment of the knowledge, behavioural determinants and health literacy questionnaire on influenza vaccination

The first objective of this study was to validate the KQ, BDQ and HLQ. To this end, some content validation and reliability tests were conducted.

5.1.1 Content and face validation of the knowledge, behavioural determinants and health literacy questionnaire

Validation is conducted to assess the ability of a questionnaire to measure what it is supposed to measure. There are various forms of validity, including content validity, construct validity (exploratory factor analysis and confirmatory factor analysis) and concurrent validity (test against the gold standard). In this study, construct validity was not assessed because the items in the questionnaire were not newly developed; hence, the need to validate the construct again would have been very low. As for concurrent validity, to the best of our knowledge, there is no gold standard against which to measure the knowledge and behavioural determinants of vaccination. As regards HL, the gold standard is mainly aimed at the functional type of HL. Therefore, at the time of the study, no gold-standard instrument was available that could be used to adequately assess the broader dimensions of HL, namely communicative HL and critical HL (Berkman et al., 2011).

However, the content validity of the BDQ and HLQ was assessed by nine experts. After receiving their feedback, some of the questionnaire items were retained even though the mean I-CVI for those items was less than 1. Retention of those items was considered appropriate given their role as essential components in the questionnaire to measure specific entity for that domain. However, the retained items were amended according to the experts' suggestions.

5.1.2 Reliability testing of the knowledge, behavioural determinants and health literacy questionnaire

Reliability was measured by analysing internal consistency and test-retest reliability (De Vet et al., 2011). In this study, KR20 was used to examine the internal consistency of KQ because it was scored dichotomously (Koo et al., 2016). On the other hand, Cronbach's alpha was used to assess the internal consistency of BDQ and HLQ because these two questionnaires were scored on a Likert scale. The ICC was used to determine the test-retest reliability of all three questionnaires.

Overall, nine items were removed from the questionnaire (three from the KQ and six from the BDQ) due to poor correlation. The removal of these items produced better internal consistency and satisfactory reliability. This process resulted in the production of a reasonable and reliable questionnaire that could be used with confidence to assess the knowledge, behaviours and HL regarding influenza vaccination among HCWs. In other words, the questionnaire was feasible, valid and reproducible and therefore suitable for use in the Phase 2 study that sought to measure the factors associated with influenza vaccination among HCWs.

5.2 Phase 2: Factors associated with influenza vaccination uptake and the effectiveness of the influenza vaccination among healthcare workers

5.2.1 Missing data analysis

The missing data analysis showed that the missing values were MCAR. When missing data is MCAR, this means that there is no systematic relationship between the missing and the observed value (Li, 2013). Hence the method that needed to be used to deal with the missing data was complete case analysis, where the analysis only included the participants with complete data.

5.2.2 Response rate

The participant response rate was satisfactory, and the number of responses exceeded the minimum amount required for the analysis. It was not possible to collect and analyse the reasons for the non-respondents because the uncompleted questionnaires were not returned. However, based on the limited information from the human resource unit, we found there were no differences between the respondents and non-respondents in term of gender, ethnicity and job categories. Previous studies have stated that the reported reasons for disinterest in participating in research studies include being male, younger age, busy with work; misplacing the questionnaire; forgetting to fill in the questionnaire; the questionnaire being too long; being unable to understand certain items in the questionnaire, lack of motivation and concerns that personal details will be revealed (Bot, A. G. J., Anderson, J. A., Neuhaus, V., & Ring, 2013; Korkeila, K., Suominen, S., Ahvenainen, J., Ojanlatva, A., Rautava, P., Helenius, H., & Koskenvuo, 2001).

5.2.3 Descriptive characteristics

The second and third objective of the study was to determine the prevalence of influenza vaccination uptake and to describe the sociodemographic characteristics, the level of knowledge, the behavioural determinants and the level of HL among HCWs.

5.2.3.1 Baseline characteristics of the study population

In general, the participants in this study were homogenous in character. Predominantly they were young adults, female, Malay and Muslim. The majority of them were registered nurses, had completed tertiary education, were from the middle-income group, and were married. A skewed gender distribution can affect the data obtained on lifestyle factors such as smoking as they are significantly less among females (Institute for Public Health, 2015b). In this study, less than 1% of the study participants were current smokers. Furthermore, only a few of them had a chronic disease. Nevertheless, the baseline characteristics were comparable with those in other nursing studies conducted in Malaysia (Fatimah Sham, Siti Munirah Abdul Wahab, Nur Adliah Orwah, Eezalela Ab Rahim, & Nur Aimi Kamarul Aizan, 2017; Norhaizan Jann & Chan, 2018).

5.2.3.2 Prevalence of influenza vaccination uptake

For the purposes of this study, the prevalence of influenza uptake was defined as uptake during the period 1 November 2016 until 31 December 2016. The information on the prevalence of uptake was obtained by using a data-based reporting method based on the immunization records held by the Public Health Unit in the studied hospitals. This is in contrast to a few previous studies that considered uptake during several influenza seasons and used the self-report method (Alenazi et al., 2018; Asma et al., 2016; Hudu et al., 2016).

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 (U.S. Department of Health and Human Services, 2018) and the 75% coverage targeted in European Union (European Centre for Disease Prevention and Control, 2017). A previous Malaysian study that measured influenza vaccination uptake for the 2013/2014 season showed a higher prevalence of 51.4% (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 (Holly Seale et al., 2009). Therefore, the results of the two studies are not directly comparable. Nevertheless, considering the fact that HCWs are a high-risk group in terms of contracting influenza, it can be said that the uptakes reported by this study and the prior study (Hudu et al., 2016) are both inadequate. Meanwhile, an Australian study reported a 22% vaccination uptake, which is similar to that of the current research (Holly Seale et al., 2009).

It should be noted that a secure comparison between the results in the current study and that in the previous studies is difficult considering the differences in the definition (prevalence period), methodology (data collection, interventional study) and vaccination policy across studies.

However, several studies have used a similar approach to that adopted by the current study, where the prevalence of influenza vaccination is estimated based on the vaccination record for the previous seasonal period. For instance, a study in Canada that used a vaccination database reported a high vaccination coverage of 75% among paediatric nurses (Norton et al., 2008). However, there was an ongoing intensive multi-component programme for influenza vaccination using evidence-based strategies in the studied hospital that may explain this much higher level of coverage. Another study undertaken in Canada measured seasonal influenza vaccination uptake by using staff vaccination records and reported an impressive 87.4% vaccination uptake for the 2009/2010 season (K. Corace et al., 2013). However, in this case, also, the effectiveness of vaccination campaign in the studied hospital likely 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, a high prevalence rate was reported for the USA by Black et al. (2018), who analysed data from the 2017/2018 National Health Interview Survey. 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, not mandatory, 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.% (Bali et al., 2013).

Furthermore, the difficulty faced in making comparisons is compounded when data for multiple different seasons of influenza is analysed because this difference leads to a range of diverse estimates. For example, the European Centre of Disease Control (ECDC) measured vaccination coverage among HCWs for eight influenza seasons between 2007/2008 and 2014/2015 and found that the median vaccination coverage rate in 2014/2015 was 25.7% (European Centre for Disease Prevention and Control, 2017). In contrast, a study that investigated prevalence in three influenza seasons from 2010 to 2012 in one European country, Italy, revealed a vaccination uptake of less than 3% (Gianino et al., 2017).

Nonetheless, despite the different measures that have been employed to assess the prevalence of influenza vaccination among HCWs and the variation in the findings regarding uptake across countries, it is widely recognized that higher coverage is necessary for proper disease control (European Centre for Disease Prevention and Control, 2017; U.S. Department of Health and Human Services, 2018).

5.2.4 Association between sociodemographic characteristics, knowledge, behaviour, HL and influenza vaccination

The fourth objective of the study was to determine the association between the sociodemographic characteristics, knowledge, behaviour, and HL of HCWs and their uptake of the influenza vaccination.

5.2.4.1 Association between sociodemographic characteristics and influenza vaccination

(a) ***Association between age and influenza vaccination***

This study found that an increase in age increased the likelihood of having influenza vaccination among HCWs. This finding is consistent with those reported in previous studies (Hulo et al., 2017; Kyaw et al., 2018; P. Lu et al., 2016; Shahrabani et al., 2009; Zetti Zainol Rashid et al., 2015). For instance, Hulo et al. (2017) showed that age of more than 40 years old predicted a higher vaccination uptake. Likewise, Lu et al. (2016) found that age of more than 50 years old increased the odds of a HCW having an influenza vaccination. The association of uptake with age could be due to the older age groups being more concerned about their general health or having a higher awareness about infectious diseases (Zetti Zainol Rashid et al., 2015).

(b) ***Association between department and influenza vaccination***

The results of this study 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 (Asma et al., 2016; H. Seale et al., 2010). We also interviewed the matrons and supervisors of the assistant medical officers regarding the vaccination policy in the individual workplace. We found that all departments in both of the studied hospitals implemented the same voluntary policy where all HCWs were encouraged to get a vaccination. Moreover, the policy stated any HCW who was opposed to having the vaccination was not penalized.

This study showed that working in an emergency department increased the likelihood of getting a vaccination as compared to working in other departments group, after adjusting for sociodemographic characteristics, knowledge, behaviour and HL (independent variables). Thus this finding supports the finding of a previous study that reported that working in an emergency department predicted vaccination receipt (Seale et al, 2010). This seemed to imply that HCWs in an emergency department had a better understanding of the influenza virus. Indeed, this inference was confirmed by the results which showed that the HCWs who were working in an emergency department had the highest mean score for knowledge about influenza and the vaccination (refer to Table 4.13 in Chapter Four). Moreover, the emergency department is considered a high-risk area (Asma et al., 2016). As HCWs in this department are first responders, they have a risk of both contracting and transmitting the disease (El Sayed, Kue, McNeil, & Dyer, 2011; Paneque & Carvajal, 2015). It has also been found that the motivations for influenza vaccination among HCWs in emergency departments are fear of transmitting influenza to their families, patient protection and self-protection (Hulo et al., 2017).

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. To the best of our knowledge, the current study is the first to report an association between working in the O&G department and influenza vaccination uptake, but there is some published data that supports this finding. Firstly, 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 (Norton et al., 2008). Similarly, a study among HCWs in a children' and women's hospital found poor vaccination coverage in the O&G department (Esposito et al., 2007) and the main reason was lack of fear about influenza.

The perceived low need and lack of fear about influenza could be due to the HCWs 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. The other possible explanation for this finding may be a poor level of knowledge about influenza. The results of this study showed, for example, that HCWs working in an O&G department had the lowest mean knowledge score about the influenza virus and vaccination. This is consistent with the previous study by Esposito et al. (2007) that found that the reason for poor coverage among HCWs in O&G Department was related to major deficiencies in their general knowledge of influenza and its prevention. Esposito et al. (2007) also found most of the HCWs who received influenza vaccination did so in order to protect their families; only a limited number stated that the main reason was to avoid the risk of transmitting the infection to their patients. This finding is very alarming because HCWs in an O&G department are managing pregnant women and newborns. If there is influenza transmission in a healthcare setting, these two vulnerable groups of patients are at risk of developing complications (World Health Organization, 2012). The finding of this study helps to identify the high-risk group and target the vaccination effectively.

(c) ***Association between job category and influenza vaccination***

Previous studies have reported that holding a job as a nurse is in general associated with having an influenza vaccination. To the best of our knowledge, this study is the first attempt to discover whether different categories of a nurse have a higher or lower association with vaccination uptake. From our analysis, we discovered that there was a significant association between community nurses and vaccination uptake. This may indicate that community nurses have a better understanding of the benefits of the vaccination. In the community case management paradigm, during an influenza outbreak community HCWs are trained to provide health services to the community in conjunction with home-based and other levels of care (World Health Organization, 2011). Furthermore, 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.

However, our analysis indicated that there were no differences in the uptake of the influenza vaccination according to gender, ethnicity, education, religion, monthly income, marital status, living with a person of a high risk of getting influenza complications presence of chronic disease or smoking. This may be due to the relatively limited scope of the study setting, which included nurses and the assistant medical officer from only two tertiary hospitals in Perak. A limited pool of potential respondents can lead to the participants being relatively homogenous in terms of sociodemographic characteristics. Moreover, due to the small number of male HCWs among the participants, we were unable to investigate whether there was a gender or smoking effect on vaccination uptake.

This is in contrast to previous study conducted in Singapore that have reported an association between influenza vaccination and sociodemographic factors such as having education level of bachelor degree or higher, being a medical staff member or allied health staff member and living with family members under the age of 16 (Kyaw et al., 2018). However, the results of this study are not comparable to those reported by the current study because different populations of HCWs were investigated.

(d) ***Association between need, lifestyle behaviour and influenza vaccination***

In this study, the need for influenza vaccination was based on living with a member of a group at high risk of getting influenza complications and the presence of chronic disease in the participant. The results of our analysis showed that there was a low need for the influenza vaccination because most of the participants were not living with a high-risk person and more than 85% of the participants did not have an underlying chronic disease.

Although living with a member of a high-risk group of getting influenza complications is one of the more common predictors for vaccination (Asma et al., 2016; Hussain et al., 2018; Wada & Smith, 2013), we did not find that living with a family member aged more than 65 years old, living with a child under 2 years old, living with a family member with a chronic disease or living with a pregnant woman were associated with vaccination uptake. This non-significant result could be due to inadequate knowledge about the types of group that are at high risk of getting influenza complications. Indeed, this inference was confirmed by the results which found that 13% of HCWs did not know the Ministry of Health recommendations about the age groups and chronic diseases that require an influenza vaccination.

A deficiency in knowledge about all of the high-risk categories for which influenza prevention is recommended has also been found in a European country. Specifically, it was cited as a likely explanation for the poor vaccination coverage in Italy (Esposito et al., 2007). Another possible reason for the lack of accurate knowledge about a high-risk group of getting influenza complications could be that participants in this study had growing families and other priorities to deal with or believed that they were not at risk of infection because they were generally healthy.

We also measured the lifestyle behaviour of HCWs to determine whether it has an effect on vaccination uptake. We selected smoking status as the lifestyle behaviour for the purposes of this study. Ninety-nine per cent of the participants were non-smokers. This was consistent with the sociodemographic makeup of the study population, most of which were female, government servants and had a tertiary level of education. It is also consistent with NHMS data (2015), which documented that the prevalence of smoking in Malaysia is lower in females, those with tertiary education and in government/semi-government employees. It was therefore not surprising that the results of the current study showed that there was no significant difference in the association between smoking behaviour and vaccination uptake in the vaccinated and non-vaccinated groups. In contrast, Wada and Smith (2013), who conducted a study among Japanese people of working age (20–69 years), found that smoking is negatively associated with influenza vaccination uptake. The difference in the results of this and the previous study could be due to the very small size of the non-smoking group in this study, which means that a comparison cannot be made.

5.2.4.2 Association between knowledge and influenza vaccination

This study also attempted to determine the relationship between knowledge about influenza vaccination and vaccination uptake among HCWs. It should be noted that this association was insignificant in the multivariate analysis. This finding is too contrast with previous studies (Atladóttir, 2014; Hulo et al., 2017; Ko et al., 2017; Zhang et al., 2011). Nevertheless, there is public health important for designing future targeted educational programmes to enhance knowledge and to correct any misconceptions.

This study did not find a statistically significant association between the knowledge score and the gender, education and job category of the participants. However, there was a significant difference in the knowledge score, according to the department in which the HCWs were working. This finding is consistent with Zhang et al. (2011). Posthoc analysis of the current study showed there was a significant difference in the mean number of knowledge score between O&G and medical department and O&G and emergency department.

Moreover, this study found that some sentinel knowledge items were significantly associated with influenza vaccination among HCWs. For instance, HCWs, who correctly answered that HCWs are more susceptible to influenza infections than other people were statistically significantly more likely to get vaccinated. More strikingly, the results revealed that there was a poor understanding among HCWs about how the influenza vaccination works. Only 28% of the HCWs correctly answered that the vaccine does not work in some persons, even if the vaccine has the right mix of viruses. Moreover, the difference was statistically significant between the vaccinated and non-vaccinated group.

Hence, future vaccination campaigns and health educational approaches should focus on the susceptibility of HCWs to the influenza virus and correct any misunderstandings on how the influenza vaccine works. This will be beneficial in terms of overcoming the misconception that the vaccine is not efficacious because previous studies have reported that respondents doubt or uncertain about the efficacy of the influenza vaccination (Hudu et al., 2016; Holly Seale et al., 2009). However, research evidence suggests vaccine effectiveness of 88% against laboratory-confirmed influenza cases (Ng & Lai, 2011). Thus, it should be stressed that vaccine efficacy is high. However, it also needs to be acknowledged that even when the vaccine has the right mix of viruses, there is still a small chance that it might not work in some persons. Overall, the critical issue here is that the information on efficacy should be delivered accurately.

On the other hand, the scores for a few of the sentinel knowledge items were not statistically different between the vaccinated and non-vaccinated HCWs. However, these items still warrant some attention and intervention. The data analysis showed that more than 70% of the participants in this study had a poor understanding that adults with influenza commonly experience nausea and vomiting. Also, about 86% of the participants had poor knowledge that symptoms typically appear 8–10 days after a person is exposed to influenza. Thus, health education programmes should focus on correcting these misunderstandings as well.

In summary, the findings of this study highlight that the education of HCWs is essential in ensuring that they have sufficient knowledge to inform their decision making in relation to having the influenza vaccination and in understanding the symptoms that they may encounter in themselves and others.

5.2.4.3 Association between behavioural determinants and influenza vaccination

This study also focused on trying to ascertain whether there is an association between having an influenza vaccination and each of the following behavioural determinants: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, health motivation, social influence, attitude and self-efficacy. Each of these determinants is discussed below.

(a) ***Association between perceived susceptibility and influenza vaccination***

Previous studies have found that perceived susceptibility is a common predictor for influenza vaccination (Alenazi et al., 2018; Asma et al., 2016; Cheung et al., 2017; Ko et al., 2017). However, we did not find an association between perceived susceptibility and influenza vaccination. This non-significant finding could be due to a lack of awareness among HCWs that they can spread the disease to patients and family members.

The data showed that 85.9% of HCWs were aware that they have a high risk of contracting influenza and 91.2% agreed that they face the highest risk in the case of an epidemic. However, a large proportion of HCWs were not aware that they could spread the infection to patients (46.2%) and family members (38.6%) if they are asymptomatic. This suggests that there is a knowledge gap among HCWs regarding the link between their perceived susceptibility while asymptomatic and the risk of spreading influenza to patients and family members. Yet, a prior study has shown that the influenza virus can still be transmitted even when HCWs are asymptomatic (Dash et al., 2004). Hence the strategy of staying at home when sick is insufficient to prevent nosocomial infection. Therefore, any future vaccination programme should place greater emphasis on the potential risk of HCWs spreading the disease to others even if they are asymptomatic, and in this way, this gap can be relatively easily filled.

(b) ***Association between perceived severity and influenza vaccination***

This study also found no significant association between perceived severity and vaccination uptake. This too contrasts with previous findings (Asma et al., 2016; Cheung et al., 2017; K. Corace et al., 2013). In the current study, the data showed that a high percentage of HCWs perceived influenza as dangerous to themselves (90.8%), patients (93.2%) and family members (94.5%). Therefore, it seems from this result and the one discussed above that HCWs are aware that influenza is a severe disease and that they have a high risk of contracting the disease. However, they seem not to be mindful that they have a higher risk of spreading the disease, especially when asymptomatic.

(c) ***Association between perceived benefits and influenza vaccination***

Furthermore, the results of our analysis showed that perceived benefits were not significantly associated with influenza vaccination. Yet previous studies have commonly reported that perceived benefits is a factor associated with influenza (Asma et al., 2016; K. Corace et al., 2013; Hakim et al., 2011; Jaiyeoba et al., 2014; Mytton et al., 2013; H. Seale et al., 2010; Shahrabani et al., 2009; Tuckerman et al., 2015). These benefits include the following: the safety of the vaccination itself, reduction in infection risk for self and patients, and protection for one's family. The non-significant result was also reported by Cheung et al. (2017), and this could be due to inadequate knowledge of the range of benefits of vaccination among HCWs (Cheung et al., 2017). In this study we found that 8.0% (n = 62), 10.3% (n = 80) and 10.1% (n = 78) of HCWs did not think vaccination could protect them, their patients, or their family members, respectively. Therefore, any future education programme should highlight the benefits of influenza vaccination in protecting HCW themselves, their patients and their family.

Moreover, surprisingly, about 35% of HCWs in both groups were not aware that one of the benefits of community vaccination is that it can reduce their workload during an outbreak. This is in contrast to the result reported by a previous study that found that HCWs who agreed that a community vaccination programme reduces their workload during an epidemic are significantly more likely to take up the influenza vaccination (Asma et al., 2016). The importance of community vaccination is exemplified by the United States Centers for Disease Control (CDC) which estimated that influenza vaccination during the 2016–2017 influenza season prevented an estimated 5.29 million cases of illness, 2.64 million medical visits, and 84,700 hospitalizations associated with influenza globally (Centers for Disease Control and Prevention, 2018a). This data highlights the community benefit of influenza vaccination in reducing doctor visits, which translates into an indirect benefit for HCWs in terms of decreasing their workload. Thus, information that community vaccination could have an added benefit for HCWs should be emphasized in any future vaccination campaign.

(d) ***Association between perceived barriers and influenza vaccination***

This study found that perceived barriers were not a significant predictor for influenza vaccination uptake. On the other hand, previous studies showed that lower perceived barriers are significantly associated with higher vaccination (Asma et al., 2016; Cheung et al., 2017; K. Corace et al., 2013; Mytton et al., 2013). In this study, the results showed that, among the non-vaccinated group, the leading barrier was that they had had or knew someone who had side effects from a previous influenza vaccination (34%), Notably, this was also a commonly cited barrier among vaccination refusers in the previous studies (Norton et al., 2008; Zhang et al., 2011). Some of the HCWs in this study might likely have confused common post-vaccination symptoms such as soreness with influenza complications. This is because, the influenza vaccine available in Malaysia is inactive tetravalent vaccine which cannot cause influenza (World Health Organization, 2012). Interestingly in this study, more vaccinated HCWs expressed concern about the side effects than unvaccinated HCWs (14.6% vaccinated vs 10.9% non-vaccinated), which implies that this issue might not be the main barrier. Hence further research is needed to explore the underlying barriers to vaccine refusal.

The second most frequently cited barrier among non-vaccinated HCWs was the belief in alternative medicine (30%). This is persistent with the study by Bleser et al that concluded that children who have ever used complementary and alternative medicine (CAM) are less likely to be immunized against influenza (Bleser, Elewonibi, Miranda, & BeLeu, 2016). The study by Bleser et al. (2016) showed that the significant types of CAM were alternative medical systems such as acupuncture and manipulative, and body-based therapies such as chiropractic manipulation. Similarly, a previous descriptive study in Malaysia has shown that the main reason for vaccination refusal among parents is their belief in alternative medicine (homeopathy) (Lim et al., 2016). Thus the relationship between CAM and vaccination in Malaysia requires further investigation.

In the current study, concern about the discomfort of the yearly injection was also identified as a barrier to vaccination. This is consistent with a previous study in Turkey (Asma et al., 2016). However, in contrast, a study conducted in Saudi Arabia reported that the vaccination-complaint group do not think that the yearly vaccination is uncomfortable (Alenazi et al., 2018). These mixed findings may relate to differences in the perception of discomfort as interpreted by study participants with different demographic characteristics. Hence, a future study should explore the uneasiness that exists about this yearly vaccination and whether the inconvenience relates to the pain, cost or time constrictions of complying with an annual vaccination regimen. Then, future vaccination programmes can target methods to ease the identified discomforts.

It is very interesting to note that the HCWs who participated in this study are not against the influenza vaccination per se. They think that the vaccination is useful and they still believe they should be vaccinated even if their patients have been vaccinated. This could be due to the feeling that it is their professional responsibility to have the influenza vaccination (Wilson et al., 2019). Besides, a previous study has shown that personal belief or religious preference is a common barrier (Lim et al., 2016). However, only 5% of participants in the current study are against vaccination due to these reasons.

Overall, in this study, we found no significant association between perceived barriers and influenza vaccination. A plausible reason for this non-significant result is that HCWs do not perceive any barriers as such, but somehow have a negative attitude towards vaccination (Cheung et al., 2017). It is therefore this aspect that needs to be further explored. In addition, it has been noted by prior research that some HCWs refuse to have a vaccination based on their low personal need for vaccination (Zhang et al., 2011).

(e) ***Association between health motivation and influenza vaccination***

As regards the effect of health motivation, this study found no significant association between health motivators and influenza vaccination. This is similar to the finding reported Alenazi et al. (2018). However, a few studies have reported that HCWs who are vaccinated have higher levels of health motivation than those who do not have the vaccination (Asma et al., 2016; Cheung et al., 2017; Zhou et al., 2013). These health motivators include knowing the Ministry of Health recommendations about influenza vaccination, having sufficient knowledge from reliable sources and access to a free vaccination.

The data in this study showed that the leading health motivations were knowing the Ministry of Health recommendations about influenza vaccination (93.8%) and the Ministry of Health providing free vaccinations for HCWs (93.3%). Although it should be noted that the results were not statistically significant, the non-significant results could be explained by inadequate knowledge about influenza among HCW.

Interestingly, the data also showed that although most HCWs received knowledge from reliable sources every year (80.4%), only half of the HCWs (49.3%) claimed that they had sufficient knowledge about influenza. This indicates that the availability of reliable sources should not be assumed to not automatically lead to HCWs being informed persons. Insufficient knowledge about influenza could be the reason for the low influenza vaccination uptake. Thus, it seems that the method of delivering the necessary information to HCWs should be improved.

(f) ***Association between social influence and influenza vaccination***

The result showed that the association between social influence and vaccination uptake was not significant. However, social influence is a commonly reported influencing variable in other studies (Asma et al., 2016; K. Corace et al., 2013). The non-significant result in this study could be because the majority of the participants were aged more than 30 years old, which is considered to denote that they are experienced HCWs who can make their own decisions. This possible explanation is in line with the study by Shahrabani et al. (2009), who reported that for experienced nurses, the main HBM factor affecting their decision is perceived benefits, while for nursing students without experience the main factor is a social influence (Shahrabani et al., 2009).

In the current study, social influence was defined as a recommendation from the relatives, healthcare providers, work colleagues and the Ministry of Health to have a vaccination. The data analysis revealed that there was a good social influence (>70%) from relatives, healthcare providers, work colleagues and the Ministry of Health to get a vaccination. Nevertheless, the result for the sentinel item in the social influence domain showed that HCWs who have relatives who think that it is important that the HCW is vaccinated were significantly more likely not to be vaccinated (OR 0.6, 95% CI 0.42, 0.86). Perhaps this is because it does not matter who gives the advice or exerts the influence. Ultimately, the final decision on whether or not to have the vaccination still lies in the hands of the HCWs themselves.

(g) ***Association between attitude and influenza vaccination***

This study did not find the attitude to be a significant factor associated with influenza vaccination. The result showed that HCWs had a pro-vaccination attitude where most of the HCWs (>87%) felt it is important for them to not spread the disease to their patients and that HCWs should get vaccinated to ensure the continuity of health services. However, the difference between the vaccinated and non-vaccinated groups was not significant. K. Corace et al. (2013) reported a contra result where the belief that all HCWs should be vaccinated to protect family members and patients from pH1N1 was a significant predictor for vaccination.

The current study also investigated the attitude of HCWs towards mandatory vaccination. The result showed that more vaccinated HCWs agreed that vaccination should be mandatory (86.4% vs 81.8%). Conversely, more non-vaccinated HCWs thought that they should be given the right to choose whether or not to have a vaccination (76.6% vs 70.2%). However, the difference was not significant. The previous study by K. Corace et al. (2013) reported that the belief that all HCWs should be vaccinated against pH1N1 is the strongest predictor of pH1N1 vaccination. It also reported that non-vaccinated HCWs are significantly more likely to agree that HCWs should have freedom of choice in vaccination (K. Corace et al., 2013). The non-significant results in the current study could be due to the fact that the sample was limited to nurses and assistant medical officers. In contrast, the study by K. Corace et al. (2013) covered HCWs in general.

Dini et al. (2018), in their critical review on influenza vaccination in HCWs, concluded that mandatory vaccination leads to a tremendous rise in vaccination uptake. However, they also noted that the idea of making vaccination mandatory is the subject of ongoing debate in several countries (Dini et al., 2018). While HCWs have a responsibility to protect their patients and the limited effectiveness of voluntary policies, thus, mandatory vaccination should be considered (Wicker & Marckmann, 2014).

(h) ***Association between self-efficacy and influenza vaccination***

In the context of this study, self-efficacy is about how confident a HCW is in getting a vaccination (Bandura, 1994). Even though self-efficacy is an essential predictor for vaccination in other studies (Alenazi et al., 2018; Asma et al., 2016), this study showed a contra result. The non-significant result of the current research could be due to the homogeneity of the study participants who were predominantly female, Malay and from the same educational and economic background. Thus the way they think and how they perceive some things may not differ that much. In contrast, the studies cited above considered all categories of HCW in general.

Interestingly, the data analysis of the current study showed that non-vaccinated HCWs had more confidence in getting the vaccination if they were given enough time and sufficient knowledge about vaccination. On the other hand, the vaccinated HCWs were more confident if someone reminded them to get a vaccination. Although the results were non-significant, they still highlight ways in which public health officials might be able to increase the uptake of the influenza vaccination, and they also support some of the findings presented in previous studies.

For instance, Asma et al. (2018) found differences between vaccination-compliant and non-compliant groups for self-efficacy ($p < 0.005$) where participants were self-competent that they would be vaccinated if they had enough time, someone reminded them, vaccination was provided at their workplace, and rewards and sufficient knowledge were given. Yue et al investigated the work interventions associated with influenza vaccination coverage and found that free onsite vaccination that was actively promoted could help increase coverage (Yue, Black, Ball, & Donahue, 2018). Research evidence also shows that multiple interventions are more likely to be successful (Heinrich-Morrison et al., 2015; Looijmans-van den Akker et al., 2010, 2011). Thus an intervention based on the component of self-efficacy should improve the confidence of HCWs in getting a vaccination.

5.2.4.4 Association between health literacy and influenza vaccination

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. These types of HL encompass the ability to extract, understand and utilize health-related information. 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. Therefore, comparisons were made with different study populations.

(a) ***Functional health literacy***

This study found that the functional HL scores tended towards the higher end of the range (1-4). This result supports the findings in NHMS (2015), where the NHMS measured functional HL using NVS. The NHMS (2015) reported that the prevalence of adequate HL was highest among adults aged 18 years and above, the urban population, those with tertiary education and those who are governmental/semi-governmental employee. By state, Perak has the highest prevalence of adequate HL (Institute for Public Health, 2015a).

However, the result of the current study did not show any significant association between functional HL and influenza vaccination uptake. This is similar to previous studies that measured the parental decision on childhood vaccination (Aharon et al., 2016; Pati et al., 2011). In contrast, 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 (Johri et al., 2015). 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. Indeed, it is likely that those with lower functional HL were underrepresented in this study. Another plausible explanation for the underrepresentation is the fact that if one perceived difficulties with reading, one would not participate in questionnaire-based research (Veldwijk et al., 2015). Furthermore, the usage of a different tool for the measurement of functional HL makes comparison difficult.

(b) ***Communicative health literacy***

The scores for the level of communicative HL also tended towards the higher end of the range. In demonstrating communicative HL, the participants in this study collected information on influenza vaccination from various sources, looked for the information they wanted and understood the information they obtained on influenza vaccines. They also communicated their thoughts about influenza vaccination to someone and applied the obtained information to make decisions regarding their influenza vaccination.

However, we 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. (2008) also showed no association between communicative HL and diabetic complications. In contrast, the study by Aharon et al. (2017) showed that parents with higher communicative HL are more at risk of not vaccinating their children. To the best of our knowledge, this study is the first to measure communicative HL and influenza vaccination among HCWs. Hence comparison with previous studies is difficult due to differences in target population and outcome measure.

In our opinion, information on influenza vaccination was available to most HCWs and they shared and discussed it among themselves. However, many of them were still undecided about the need to have a vaccination. 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 influenza vaccination information. Furthermore, the results of the univariate analysis showed that HCWs with a higher score for the statement "I understood the obtained information on influenza vaccines" were significantly more likely to get the influenza vaccination. 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.

(c) ***Critical health literacy***

The final component of the HL scale was critical HL. The data showed that the level of critical HL was towards the higher end. In this component, they considered whether the vaccination was applicable to them; they checked the credibility and accuracy of the information and used this information to decide on vaccination. Crude analysis showed that there was a significant association between critical HL and vaccination uptake among vaccinated and non-vaccinated HCWs. However, the association was not significant in the multivariate analysis after adjusting for the sociodemographic, knowledge and behavioural variables.

Previous studies have reported multiple directions in the relationship between critical HL and preventive action or health outcome. For instance, Ishikawa et al. (2008) reported that critical HL has a positive association with health outcome related to diabetes knowledge and self-efficacy (Ishikawa et al., 2008). In contrast, Aharon et al. (2017) showed that critical HL has an indirect effect, mediated through other variables on the parents' completion of a child vaccination protocol. Furthermore, the pathway suggested that parents with high critical HL are more likely not to vaccinate their children (Aharon et al., 2016).

One of the sentinel item in critical HL was the question: “Did you consider whether the information was applicable to your situation”. The HCWs with a higher score for this question had a significant association with influenza vaccination uptake in the univariate analysis. This indicates that the applicability of information is crucial in influencing vaccination behaviour. Thus, a future vaccination programme should disseminate influenza information that is relevant and highlight how it is explicitly applicable to HCWs.

Overall, the relationship between all scales of HL remains unclear, and it seems that a similar conclusion was drawn by Lorini et al. (2018) in their systematic review on HL and vaccination. The reason for the lack of clarity could be due to differences in the methodology in terms of tool used to assess HL, target population and outcome measure. Therefore, future studies should use tools that are specific to vaccine literacy to gain a better understanding of how HL predicts vaccination behaviour or moderates the effect of other determinants of vaccination behaviour.

5.2.5 Effectiveness of influenza vaccination on work absenteeism

The fifth objective of this study was to determine the effectiveness of the influenza vaccination on absenteeism among HCWs. The result showed that there was an increase in absenteeism among non-vaccinated HCWs as compared to vaccinated HCWs, although the difference was not significant. This mirrors the result of a study among HCWs in residential nursing homes (Michiels et al., 2011) and that of a study among Malaysian petrochemical workers (Abu H Samad et al., 2006).

In contrast, a Cochrane review of trials conducted in temperate and high-income countries among healthy adults reported that the number of working days lost was significantly reduced in the vaccinated group with an average reduction of less than half a day (Jefferson et al., 2012). The result of this study also contradicts to another study in a tropical country that was conducted among Singaporean HCWs. The result of the study in Singapore showed that there was a significant reduction in work absenteeism in HCWs who received the matched vaccine, compared with those who did not receive the vaccination (Kheok et al., 2008). However, the protective effect was not significant if the match was poor. This implies that having a matched vaccine is important in monitoring vaccine effectiveness. However, in Malaysia, influenza subtyping is not routinely done. Sam et al. (2018) reported that 14.1% of the influenza A strains are still untyped, while influenza B is not routinely typed except the relatively small numbers sent to the WHO GISRS. Thus, research on the matched vaccine is limited. Moreover, Zaffina et al conducted a retrospective observational study among HCWs in a paediatric hospital in Italy also recorded significantly higher average working days lost in unvaccinated HCWs in the 2016/2017 and 2017/2018 epidemic seasons (Zaffina et al., 2019).

The discrepancies in the results of this study and other studies could be explained by the intensity or duration of the epidemic, the strains of influenza virus, the match between the vaccine and the circulating virus and the work culture. They could also be due to differences in methodology, including the study design, study population, and methods of reporting work absenteeism, all of which may impact the estimation of work absenteeism. Moreover, where there is low vaccination coverage among the participants, it follows that vaccination cannot have a significant impact on the trend of work absenteeism.

Nevertheless, this study found that the total workdays lost due to influenza among non-vaccinated HCWs were 1.44 times higher than among the vaccinated group in the studied hospitals (39 days/100 subjects in the non-vaccinated group vs 27 days/100 subjects in the vaccinated group). This finding could motivate policymakers to strengthen the implementation of an influenza vaccination programme among HCWs and to encourage HCWs to be immunized against influenza.

5.3 Limitations of the study

The current study has several limitations. First, in the Phase 1 validation study, construct validity was not assessed. Hence some of the questionnaire items may not belong to the construct. Moreover, the questionnaire was not tested against a gold standard. However, to the best of our knowledge, there is no gold-standard questionnaire to assess behaviour related to vaccination. In the case of the HLQ specifically, a few gold standards do exist, such as the S-TOFHLA and NVS. However, these questionnaires only focus on functional HL and are not user-friendly, especially in critical or crisis areas such as the hospital setting (Glashen, 2015).

Second, as the Phase 2 study was an observational cross-sectional study, causal relationships could not be inferred. Third, 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 the district and private hospitals in Malaysia to better understand the vaccination behaviour among HCWs. Furthermore, the study population in Phase 1 was different from the study population in Phase 2. In the validation study, we include all category of HCW (44% Nurse, 17% doctor, 8% health assistant, 7% assistant medical officers, 4% pharmacist, 20% others), meanwhile in the actual study we only include nurses (84.5%) and assistant medical officers (5.5%). Although doctors constitute the second largest group in both hospitals, they were mobile, making them difficult to locate and were transferred between departments. Hence, due to time limitation and difficulty in achieving good response, doctors and other categories of HCW were not included in the Phase 2 study. The differences in study population selection in validation and actual study may affect the outcome of the study because some questions maybe too difficult to be answered for the assistant medical group in the actual study.

Fourth, information bias with regards to influenza-related absenteeism cannot be ruled out. This is because the information was self-reported and was not verified with secondary sources such as medical leave certificates or medical records to confirm the diagnosis of an influenza-related illness. Recall bias can be an issue where participants might not remember how many sick days they have taken due to an ILI. In the Malaysian setting, medical leave records are recorded in a human resource management information system that requires an individual password, or they are recorded in an individual service book which is strictly confidential. Hence, getting access to such records was difficult. To minimize the possibility of errors, for participants with an extreme number of sick days we verified the information with the attending physician or with a medical report. As a result of this procedure, one participant was excluded from the analysis due to a diagnosis not related to influenza.

Fifth, we also unable to rule out information bias with regards to sickness presenteeism where HCWs, who is sick but still present for work. This sickness presenteeism may have a false positive impact on the estimation of the effectiveness of influenza vaccination.

Sixth, this study may not have captured other predictors of influenza vaccination uptake. The study did not include a free-text response option, so we may have missed factors that were not included in the questionnaire. The questionnaire was designed based on the HBM constructs with HL as an additional component to obtain information on the vaccination behaviour of HCWs. However, the results showed no relationship between behaviour, HL and vaccination uptake. Therefore, the HBM might be inadequate in terms of explaining the vaccination behaviour identified in this study. Thus others health behaviour theories such as the theory of reasoned action, the theory of planned behaviour or stages of change model could have been applied in this study in complement to the HBM. Moreover, HL may be linked to several constructs of the HBM in different pathways. Therefore, further research would need to be undertaken to determine how HL and the HBM constructs predict vaccination uptake.

5.4 Strengths of the study

Most influenza studies in Malaysia have been conducted in the Klang Valley and Selangor, and they have been small or descriptive and limited to self-reported influenza vaccination uptake. Therefore, 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. The HLQ was modified and validated to specifically reflect the topic of influenza vaccination. Last but not least, this is the first study in Malaysia to measure the effectiveness of influenza vaccination on work absenteeism among HCWs.

5.5 Clinical implications

The results of this study revealed that the prevalence of influenza vaccination coverage was low at 25.5%. This may have an impact on patient safety because of the low vaccination uptake among HCWs increases the risk of spreading the disease in the healthcare setting. The influenza vaccination should be considered as an ethical professional commitment and a patient safety issue. Public health officials should include influenza vaccination coverage as a measure of the quality of care as part of a patient safety goal and an infection control strategy (World Health Organization, 2012).

Based on an occupational health perspective, a HCW is at higher risk of contracting influenza due to work exposure and therefore, the influenza vaccination is an important preventive action (Kliner et al., 2016). Furthermore, when a HCW takes sick leave due to influenza, it is costly and disrupting the continuity of the provision of health services. Again, the HCW should take the professional responsibility to be vaccinated.

With regards to HL, this factor was shown to be an essential influencing factor in vaccination behaviour among HCWs. The healthcare providers, for example, the clinician should be continuously updated about the consequence of poor HL on clinical outcomes. The validated HLQ can be used as an assessment tool to measure the level of HL. Hence consequence of limited HL can be addressed. The clinician should also be aware that the decision on vaccination requires a broader range of communication skills and critical thinking than commonly used. Hence effective communication can be supported by “literacy sensitive” services such as minimise health instruction or simplify form-filling. Besides, the clinician should use more sophisticated communication tool to explain vaccine importance such as social media.

5.6 Public health implications

5.6.1 Impact on the planning and design of health programmes

The influenza vaccination is the most effective way to prevent the infection. However, this study showed that the uptake among HCWs was low at 25.5%. The factors that were found to be significantly associated with the uptake were sociodemographic characteristics such as age, working as a community nurse, working in an emergency department and O&G department. These findings help in identifying the high-risk group; however, not much can be done due to limited changeability. Notably, modifiable variables such as knowledge, behaviour and health literacy were not significant factors associated with influenza vaccination in this study. Based on the health belief model, we hypothesize some of the model variables to be the significant factors associated with influenza vaccination. However, the results were defied expectations and too contrast from previous studies. Having said that, there is an evident trend that the vaccinated HCWs had a higher knowledge score, positive behaviour towards vaccination and higher health literacy score as compared to the non-vaccinated HCWs. These findings had clinical significance in public health practice; hence, various targeted interventions should be implemented based on the above modifiable factors to increase the rate of vaccination uptake.

Furthermore, misconceptions about the influenza virus and vaccine warrant some interventions in the future health education programme and should focus on correcting the misunderstandings. Commonly cited barriers in this study, such as fear of side effects, belief in alternative medicine and discomfort of yearly vaccination should be highlighted, then future vaccination program can target methods to ease the identified barriers. The result of this study also highlights the strategies to increase motivation or to influence vaccination decision. This includes expanding vaccine accessibility at the workplace such as extending the provision of vaccination after office hours or set up a mobile clinic to give the injection. Besides, the study finding highlights the importance of social influence from a relative to increase the vaccination uptake. Hence, future vaccination campaigns should also inform people close to HCW such as sending a personal invitation letter for the influenza plenary meeting to the home address of HCW together with an information leaflet.

Furthermore, the study results highlight the importance of understanding component in communicative HL and applicability component in critical HL in influencing vaccination behaviour. Hence, the strategies to increase vaccination uptake should aim to increase understanding of the obtained information and to increase awareness about the applicability of influenza vaccine in HCWs situation. This can be done by providing a short and clear message about influenza information in leaflet, poster or websites. The other method is via 1-hour plenary meeting to disseminate influenza information by a credible person such as physicians or trained nurses. Small group discussion also works to create interaction between HCWs and exchange knowledge and experiences about influenza vaccination.

Finally, the study finding showed there is an implication of influenza vaccination in reducing influenza-related work absenteeism, where vaccinated HCW showed a lower number of influenza-related absenteeism. HCW should be convinced that vaccination is benefited by providing the effectiveness information via reading materials, plenary meeting, group discussion or video show with role-models.

5.6.2 Impact on policy development and implementation

An influenza vaccination policy for HCWs in Malaysia has already been established. It includes a free and non-mandatory annual vaccination programme. However, policymaker should be highlighted of the low uptake of the influenza vaccination among HCWs. To ensure adequate vaccination, we would like to make some recommendations. First is to implement a targeted interventional program as described above. The other possible options given the partial success of the interventional program are to implement mandatory vaccination. Since HCWs have a responsibility to protect their patients and limited effectiveness of the voluntary policies, thus, mandatory vaccination should be considered (Wicker & Marckmann, 2014).

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 (Amin et al., 2010; U.S Department of Health and Human Service Office of Disease Prevention and Health Promotion, 2010). In the USA, one of the policy aims is to develop and disseminate accurate, accessible, and actionable health and safety information and promote changes in the healthcare delivery system that improves HL (US Department of Health and Human Service, 2010). In Singapore, the Health Promotion Board in 2010 developed an action plan to enhance HL and suggested that one of the steps to achieve this would be to develop a tool to establish a baseline and measure the level of HL (Amin et al., 2010). The current study has assisted in validating an instrument for HL measurement. This tool will hopefully be helpful in estimating the level of HL and the consequences on health outcomes.

5.6.3 Impact on the effectiveness of the vaccination programme

The results of this study showed that HCWs agreed that the benefit of the influenza vaccination lies in reducing the risk of contracting the infection and spreading the disease. The benefit of this vaccination was proven by the lower number of influenza-related work absenteeism in the vaccinated group. The effectiveness of the vaccination will not just benefit HCWs but the employer as well. Providing HCWs with the vaccination will benefit the employer by reducing work absenteeism and protecting the health of HCWs to ensure thereby a high quality of care is provided to patients. The health benefits translate into financial benefits for the employer. Cost savings due to reduced absenteeism will definitely benefit the employer.

5.6.4 Impact on immunization advocacy

Immunization advocacy works basically to generate and maintain support for the influenza vaccination programme. The three audience categories that need to be reached out to are the public, policy leaders and mass media.

Based on the study findings, the theoretical approach based on HBM is the best way of approaching and influencing the vaccination behaviour of the public. The theoretical model has been useful in designing effective behaviour change intervention, especially those aimed at increasing the uptake of influenza vaccination. Then, the finding of the effectiveness of the influenza vaccination programme will likely reach policy leaders and positively affect the sustainability of the current programme. Furthermore, the advocacy campaign should also target mass media and use the study findings to provide evidence-based information to influence public opinion and educate them on the importance of the influenza vaccination. To achieve the maximum result, the advocacy work should target the three audiences simultaneously. Through diverse interaction, they will influence one another to ensure a successful advocacy campaign.

5.6.5 Impact on the relationship with other organizations

The results of this study that show the effectiveness of the influenza vaccination will have an impact on other essential services, i.e., front-liners in other government departments such as police and immigration officers. The effectiveness of the influenza vaccination will impel or sensitize other departments to implement an influenza vaccination programme. This is because by knowing the benefits of such a programme, they will commit to its success.

5.7 Chapter summary

Influenza vaccination among HCWs is an essential preventive action that can be taken in order to stop the transmission of influenza disease. Factors that were significantly associated with influenza vaccination uptake were sociodemographic include age, department and job category. The influenza vaccination was effective in reducing work absenteeism where the total number of workdays lost among non-vaccinated HCWs was 1.44 times higher than among the vaccinated group in a 12-month period. The results of this study will trigger public health action to form strategies to encourage higher vaccination rates among HCWs.

CHAPTER 6: CONCLUSION

About this chapter

This chapter concludes the findings in this study and offer some recommendations for public health practices and future studies.

6.1 Introduction

The overall purpose of this study was to investigate the range of factors (sociodemographic, knowledge, behaviour and HL) associated with influenza vaccination among HCWs and the effectiveness of the vaccination on work absenteeism. To achieve this goal, in Phase 1 of this study, the Knowledge, Behavioural Determinants and Health Literacy Questionnaire was developed and validated for use in Malaysia. Then in Phase 2, the questionnaire was utilized in a quantitative cross-sectional study conducted among HCWs in two tertiary hospitals in Perak.

6.2 Phase 1: The psychometric assessment of the knowledge, behavioural determinants and health literacy questionnaire on influenza vaccination

The KQ, BDQ and HLQ were tested for content validity, internal consistency and test-retest reliability. The results showed that they appeared to be feasible and demonstrated adequate validity and reliability for measuring the level of knowledge, behaviour and HL related to influenza vaccination in Bahasa Melayu, the national language of Malaysia.

6.3 Phase 2: Factors associated with influenza vaccination and effectiveness of the influenza vaccination among healthcare workers

6.3.1 Prevalence, sociodemographic characteristics and level of knowledge, behaviour and health literacy regarding influenza vaccination among healthcare workers

(a) ***Prevalence and sociodemographic characteristics***

This study showed that the prevalence of influenza vaccination among HCWs was low (25.5%) despite the study population having what could be said to be a good sociodemographic background. The analysis of the sociodemographic characteristics showed that 87% of the participants had a tertiary level of education, 74% of them were registered nurses and 58% had an income of more than RM3000 per month. However, the low vaccination uptake in the population might be due to the low need for vaccination. The results showed that 85% of the participants did not have a chronic disease and 73% did not live with a person at high risk of developing influenza complication.

(b) ***Level of knowledge***

The level of knowledge about the influenza virus and the vaccination tended towards the higher range with a mean score of 4.96 (range 2–8). A higher knowledge score was observed among participants who were male, in the sister job category and working in the medical department. However, some misconceptions were found to exist among the study population with regards to how the vaccination works and the signs and symptoms of influenza in adults, as well as the period of incubation of influenza virus.

(c) ***Behaviour towards influenza vaccination***

A range of behavioural domains was investigated to understand the vaccination behaviour of HCWs. These domains were perceived susceptibility, perceived severity, perceived benefits, perceived barriers, social influence, health motivators, attitude and self-efficacy. The median score for all domains in both the vaccinated and non-vaccinated groups was at the higher end of the range. This indicated that participants had positive behaviour towards influenza vaccination.

(d) ***Health literacy***

This study considered a broader dimension of HL when investigating whether this factor had an influence on vaccination uptake. Not only functional HL but also communicative HL and critical HL were measured to determine vaccination behaviour. The results showed that the mean scores for all three HL domains were higher among the vaccinated than non-vaccinated HCWs (mean score functional HL 3.08 vs 3.06, communicative HL 2.80 vs 2.72 and critical HL 3.09 vs 2.99, respectively).

6.3.2 Association between sociodemographic status, knowledge, behaviour, health literacy and influenza vaccination among healthcare workers

It is essential to identify the high-risk group (sociodemographic profile) and the modifiable factors for vaccination uptake (knowledge, behaviour and HL) in order to find ways to strengthen the influenza prevention programme. Initially, we found that working in a medical (OR 1.52; 95% CI 0.13, 1.54), O&G (OR 0.16; 95% CI 0.09, 0.31), anaesthesiology (OR 1.91; 95% CI 1.07, 3.43), paediatric (OR 1.85; 95% CI 1.13, 3.02), and emergency (OR 2.81; 95% CI 1.48, 5.35) department and knowledge (OR 1.22; 95% CI 1.06, 1.42) were associated with influenza vaccination univariately.

However, multivariately, the significant factors that were associated with influenza vaccination were age (OR 1.04; 95% CI 1.01, 1.08), community nurse (OR 8.48; 95% CI 1.33, 54.0), working in an O&G department (OR 0.17; 95% CI 0.04, 0.85) and working in an emergency department (OR 7.20; 95% CI 1.45, 35.69). Then, in the final model, only three factors remained significant: working in an O&G department, working in an emergency department and being a community nurse.

In short, this study found that three sociodemographic characteristics (age, job category and department) were the most significant factors associated with influenza vaccination. Although the other modifiable factors (knowledge, behaviour and HL) were non-significant, a theoretically based intervention (the HBM) is more likely to be successful in influencing vaccination behaviour. Hence, various targeted interventions should be implemented, based on a theoretical approach, in order to increase the rate of vaccination uptake.

6.3.3 Effectiveness of the influenza vaccination on work absenteeism

There was no significant reduction in mean sick leave in the vaccinated as compared to the non-vaccinated HCWs. However, the total workdays lost during the past 12 months was 1.44 times higher in the non-vaccinated compared to the vaccinated group (39 days/100 subjects in the non-vaccinated group vs 27 days/100 subjects in the vaccinated group), giving vaccination effectiveness of 30.8%.

6.4 Recommendations

Based on the results of this study, we offer some recommendations to improve the influenza vaccination programme. First, policymakers should be made aware of the poor uptake of the influenza vaccination among HCWs, which was found to be 25.5%. This coverage is not adequate for disease prevention. Since HCWs have a responsibility to protect their patients and limited effectiveness of the voluntary policies, thus mandatory vaccination should be considered.

Second, we found that sociodemographic characteristics such as age, working in the emergency and O&G departments, and being a community nurse were significantly associated with influenza vaccination. The study has therefore helped to identify the high-risk groups. Thus targeted interventions can now be channelled towards these priority groups.

Third, although knowledge was not a significant factor associated with influenza vaccination in this study, there is public health important to ensure adequate and correct information is delivered during vaccinations campaign. Based on the study findings, there were misconceptions with regards to how the vaccination works, the influenza signs and symptoms and the period of incubation, all of which should be highlighted and addressed.

Fourth, although the HBM variables were not significant predictors in this study, several items warrant some attention and intervention. Based on the study results, perceptions of the susceptibility to and severity of influenza and perceptions of the benefits of the influenza vaccination should be focused on in order to ensure high uptake of the vaccination. The barriers to vaccination also need to be removed. In particular, misconceptions about the side effects of the vaccination and false beliefs about the effectiveness of natural methods and alternative treatments should be eliminated. The approach adopted to remove these barriers should include the provision of accurate and applicable information about influenza and the vaccination by a credible person in order to improve the knowledge and HL of HCWs.

Fifth, the implementation of the programme should involve a variety of coordinated managerial and organizational elements (e.g., occupational health units and nursing department). The findings of the study showed that HCWs would get vaccinated if they have enough time, someone reminds them, and the vaccination is provided in the workplace. Thus public health officials should facilitate vaccine accessibility in the workplace by, for example, extending the provision of the vaccination after office hours, providing a mobile clinic to visit every ward to give the injection and giving reminders prior to the vaccination period through, for example, announcements, memos, and message via a WhatsApp group etc.

Sixth, school health education provides an important foundation for HL. Hence, the training program in nursing or medical school should include teaching future HCWs about vaccination literacy as part of their curriculum. This includes by providing them adequate training, tools and resources for these future HCWs to empower them on health information-seeking and decision-making skills about vaccination.

Seventh, a HL assessment should be conducted because it is crucial for a proper estimation of the consequences of poor HL among HCWs. The validation of the HLQ related to vaccination that was performed in this study has resulted in the creation of an appropriate measuring tool for the assessment of the broader dimension of HL. Importantly, this tool is user-friendly (pen and paper) and available to all healthcare providers. If the HL of HCWs or patients is assessed and attended to, this could have a positive impact on preventive health action.

6.5 Future studies

Base on the experience of exploring this research topic and the findings and limitations of this study, several recommendations can be offered to provide directions for future studies. First, the validation of the knowledge, behaviour and HL questionnaires should include construct validation in order to explore whether factor analysis could help clarify the ambiguity in the items in the construct. Furthermore, the HL scales that were used in this study should be tested against the gold standard to assess their criterion validity.

Second, future studies should involve all categories of HCW in multiple locations in order to represent this occupational group better. This study was conducted at two tertiary governmental hospitals, one in an urban and the other in a suburban area. HCWs in the private sector will likely have a different attitude towards influenza vaccination because some of the private centres do not have a policy on influenza vaccination. The situation in district hospitals and health clinics should also be explored because they do not have many dealings with critically ill patients; hence, the level of risk and severity may be perceived differently.

Third, performing a prospective study would open up more opportunity to determine the temporal relationship between risk factors and influenza vaccination uptake. Exposure variables such as previous vaccination and years of service, which were not considered in this study, would give more information on the factors associated with vaccination uptake and therefore should be explored. A prospective study is also appropriate for measuring other potential benefits of influenza vaccination because it avoids the introduction of recall bias. The benefits that may be of interest to future researchers are reduction ILI symptoms, presenteeism at work despite being symptomatic and time to return to work after illness.

Lastly, a high impact study could be conducted on topics of interest to policymakers, such as measuring the burden of influenza disease or conducting a vaccination cost-benefit analysis. The results of such a study may then have an influence on policymaking in the area of influenza control.

6.6 Chapter summary

Influenza will continue to be a significant public health problem if effective strategies to ensure high vaccination coverage is not being taken. The factors associated with influenza vaccination uptake among HCWs identified in this study were sociodemographic factors. The study finding hopes to provide an opportunity for improvement to ensure adequate influenza vaccination coverage. Based on the study findings, a few recommendations were discussed.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

1. Factors Associated with Influenza Vaccination Uptake among Healthcare Worker in Tertiary Hospital in Perak, Malaysia
   Journal of Malaysian Academy of Science (ASM)

2. Technical Meeting Department of Public Health, Perak State Health Department
   Study Proposal - Prevalence, Associated Factors Of Influenza Vaccination Uptake and Effectiveness of Influenza Vaccination among HCW in Perak
   4th October 2017

3. 5th AHLA International Health Literacy Conference 2017
   Research Management Complex (RMC) Building, University of Malaya
   Poster Presentation: Validation of Health Literacy Questionnaire related to Influenza Vaccination among Healthcare Workers in Selangor
   (Best poster presentation)
   12th-14th November 2017

4. 5th Regional Conference of Occupational Health (RCOH) 2018
   Royale Chulan Damansara Hotel, Kuala Lumpur
   Poster Presentation: Association between Healthcare Workers' Knowledge of Influenza Vaccination and Vaccination Behaviors in Tertiary Hospitals, Malaysia
   13th – 15th September 2018

5. 12th Asia-Pacific Rim Universities (APRU) Global Health Conference 2018
   Research Management Complex (RMC) Building, University of Malaya
   Oral presentation: Prevalence and Factors Associated of Influenza Vaccination Uptake Among Healthcare Workers in Tertiary Hospital in Malaysia
   28th- 30th October 2018

6. 6th Asia Pacific Conference on Public Health (APCPH), Penang
   Poster presentation: Effectiveness of Influenza Vaccination among Healthcare Workers in Tertiary Hospitals in Perak
   (Best poster presentation)
   22th July 2019 – 25th July 2019