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Review

Factors influencing pandemic influenza vaccination of healthcare workers—A systematic review

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ABSTRACT

Introduction: Maintaining the health and availability of Health care workers (HCW) is an essential component of pandemic preparedness. A key to protecting HCW during the H1N1 pandemic was influenza vaccination. Numerous researchers have reported on factors influencing H1N1 vaccination behaviour in various HCW groups. This systematic review aims to inform future influenza vaccine interventions and pandemic planning processes via the examination of literature in HCW H1N1 vaccination, in order to identify factors that are (1) unique to pandemic influenza vaccination and (2) similar to seasonal influenza vaccination research.

Methods: We conducted a comprehensive review of literature (MEDLINE, PubMed, EMBASE, PsycINFO, CINHAL, AMED, Cochrane Library, ProQuest, and grey literature sources) published between January 2005 and December 2011 to identify studies relevant to HCW pH1N1 vaccine uptake/refusal.

Results: 20 publications sampling HCW from different geographic regions are included in this review. H1N1 vaccine coverage was found to be variable (9–92%) across HCW populations, and self-reported vaccine status was the most frequently utilized predictor of pandemic vaccination. HCW were likely to accept the H1N1 vaccine if they perceived, (1) the H1N1 vaccine to be safe, (2) H1N1 vaccination to be effective in preventing infection to self and others (i.e. loved ones, co-workers and patients), and (3) H1N1 was a serious and severe infection. Positive cues to action, such as the access of scientific literature, trust in public health communications and messaging, and encouragement from loved ones, physicians and co-workers were also found to influence HCW H1N1 uptake. Previous seasonal influenza vaccination was found to be an important socio-demographic predictor of vaccine uptake. Factors unique to HCW pandemic vaccine behaviour are (1) lack of time and vaccine access related barriers to vaccination, (2) perceptions of novel and rapid pandemic vaccine formulation, and (3) the strong role of mass media on vaccine uptake.

Conclusions: Many of the factors that influenced HCW pandemic vaccination decisions have previously been reported in seasonal influenza vaccination literature, but some factors were unique to pandemic vaccination. Future influenza vaccine campaigns should emphasize the benefits of vaccination and highlight positive cues to vaccination, while addressing barriers to vaccine uptake in order to improve vaccine coverage among HCW populations. Since pandemic vaccination factors tend be similar among different HCW groups, successful pandemic vaccination strategies may be effective across numerous HCW populations in pandemic scenarios.

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Contents

1. Introduction

Vaccination of healthcare workers (HCW) against influenza is an established mode of infection control in healthcare settings [1–4]. The immunization of HCW against H1N1 was especially important during the 2009/2010 influenza pandemic [5,6]. At pandemic onset, the World Health Organization (WHO) recommended the prioritized and rapid immunization of HCW against the influenza strain H1N1 as a means of protecting the integrity of healthcare systems and national infrastructure [7,8]. Health authorities of many countries adopted WHO recommendations and the prioritized immunization of HCW against pandemic H1N1 (pH1N1) was decided to be an integral component of pandemic preparedness processes throughout the globe [5,7,8].

pH1N1 provided researchers the opportunity to explore influenza vaccine uptake when a specific group is targeted for rapid immunization during a pandemic, and a number of studies have investigated various factors that influenced HCW pH1N1 immunization behaviour. Although numerous publications have reported on various reasons, attitudes, beliefs, knowledge gaps, and predictors relating to pH1N1 immunization in HCW populations, no formal review of this literature presently exists. Therefore, this systematic review examines key factors reported to have influenced pandemic influenza immunization among HCW from different geographic regions during the 2009/2010 influenza pandemic.

Theories of health behaviour offer researchers a theoretical framework to understand factors relating to specific health behaviours, including immunization uptake and/or rejection [9–12]. In recent years, the Health Belief Model (HBM) (Rosenstock, 1966) has provided a valuable theoretical framework for understanding factors that influence seasonal influenza vaccine uptake or refusal in a variety of populations [9,11,13,14]. In fact, the HBM constructs have been especially robust in explaining influenza vaccination decisions in HCW populations [9,13,15,16].

According to this theory, influenza vaccine uptake can be understood by way of 5 key constructs:

(1) perceived barriers to accepting vaccination,
(2) perceived benefits of accepting vaccination,
(3) perceived susceptibility to influenza infection,
(4) perceived severity of influenza infection, and
(5) cues to action (i.e. internal and external stimuli that serve as motivators for vaccination uptake).

Research has demonstrated the utility and validity of the HBM constructs in predicting seasonal influenza vaccine uptake, thus suggesting that these constructs will also explain pH1N1 vaccine uptake [13,15,17]. As such this review uses the five HBM constructs to better understand the factors that directed HCW influenza vaccination behaviour during the H1N1 pandemic. Additionally, predictive factors that are not explained by the HBM paradigm, such as socio-demographic characteristics, will also be identified to further understand and inform the future delivery of influenza vaccination among HCW.

Better understanding of the factors influencing influenza vaccine uptake can lead to the development of more effective interventions with improved vaccine coverage. Much like previous reviews focusing on HCW seasonal influenza vaccination behaviour, this systematic review aims to inform the design and development of future influenza campaigns and pandemic planning processes via the investigation of factors that influenced HCW pandemic influenza immunization. To achieve this goal we intend to determine factors unique to pandemic influenza vaccination and factors congruent with previous seasonal influenza vaccination research using the HBM.

2. Material and methods

2.1. Literature search strategy

Bibliographic databases and electronic data sources were searched using a pre-defined literature search strategy; the following data sources were searched to identify relevant publications: MEDLINE, PubMed, EMBASE, PsycINFO, CINHAL, AMED, and Cochrane Library, Select conference papers (ProQuest Conference Papers Index), dissertations and theses (ProQuest Dissertations and Theses) databases, and websites of various public health authorities (ref to appendix for full list) were hand searched based on keyword searches to identify additional grey literature of relevance (September–December 2011). Finally, the reference sections of all articles included in this review were scanned to identify additional publications of interest that may not have been captured by the database search.

2.2. Study selection

Following de-duplication, the titles and abstracts of all identified publications were screened by a reviewer (CP) for relevance. All

publications remaining after the initial screen were independently screened by two reviewers (CP and RP) using the study selection criteria to establish final inclusion in the review. Only the second screening process was duplicated as a method of minimizing selection bias, and differences in agreement were resolved by consensus after discussion.

The study selection criteria applied during the study selection process is as follows,

Population: Healthcare workers were defined to be all individuals employed in a healthcare setting, including persons who provide direct patient care (e.g. physicians, nurses, and allied HCW), as well as persons who indirectly support health services (e.g. healthcare administration and support staff). Study populations that were not composed exclusively of HCW were included in the review if immunization rates and factors relating to immunization are reported separately for HCW subgroups.

Intervention: This review is limited to studies that focused on pH1N1 influenza immunization during the 2009/2010 pandemic; a distinction between adjuvant and non-adjuvant vaccine types is not made.

Comparator: pH1N1 influenza immunization acceptance is compared to pH1N1 influenza immunization rejection. Only actual vaccination behaviour is considered while intentions towards vaccine uptake/refusal are excluded.

Outcomes of interest: includes all factors, such as key reasons, beliefs, attitudes, behaviours, knowledge gaps, and socio-demographic predictors found to be important in HCW pH1N1 immunization uptake or rejection. All study reported outcomes are considered factors relevant in pH1N1 immunization uptake or refusal if they demonstrate statistical significance (p-value < 0.05) or are reported in high frequency (>30% frequency) by the study population of interest.

Study design: The review includes observational, non-interventional (e.g. cross-sectional surveys, mixed methods, and semi-structured interviews) studies.

This review is limited to English language articles published between January 1st, 2005 and December 1st, 2011. Duplicate publications that report similar findings from the same study or dataset are only included in the review once, in such cases only the most recent publication was selected and included in the review.

2.3. Data extraction and coding

One reviewer (CP) extracted data from all included studies while the secondary reviewer (RP) cross referenced all extracted data with each publication's full text for accuracy and completeness. When there was a conflict of interest due to authorship (i.e. Corace et al.) the secondary reviewer (RP) assumed the role of the primary reviewer and extracted data from the publication, and the other reviewer (CP) cross-referenced the extracted data.

The primary aim of the data extraction process was to capture the entire range of behavioural and socio-demographic factors that influenced HCW pH1N1 vaccine uptake/rejection throughout the pandemic. All factors reported to be influential in HCW pH1N1 immunization outcomes were coded into five major categories using the HBM constructs. This classification strategy stems from previous research in seasonal influenza vaccination behavioural determinants [15]. Additionally, statistically significant predictors of HCW pH1N1 immunization status that are not defined by the HBM, such as socio-demographic factors, were also identified.

A log of all study selection, data extraction, and coding process by both reviewers was maintained to ensure transparency and consistency. All review procedures were based on PRISMA guidelines [18].

3. Results

As shown in Fig. 1, the literature search of all data sources yielded a total of 372 publications. Following the removal of exact duplicates 229 articles remained. During the initial round of screening, a total of 172 citations were removed by the primary reviewer (CP). The most frequent reasons for study exclusion during the primary screen include subjective reports or commentaries regarding the pandemic that do not refer to a particular study, studies that investigate non-influenza or seasonal influenza immunization, as well as non-HCW study populations (i.e. pregnant women, patients). The remaining 57 articles were separately screened by both reviewers during the secondary screen, and an additional 37 publications were excluded by the application of inclusion criteria. The most frequent reasons for study exclusion at this phase are studies relating to pandemic vaccine effectiveness, efficacy, or adverse events, and the use of pH1N1 vaccine intention as the outcome of interest. The level of agreement between the two reviewers (CP and RP) following the secondary round of screening was 95%. Following discussion 100% agreement was achieved by consensus between the reviewers.

Information extracted and coded by the primary reviewer was cross-referenced against each publication's full-text by the secondary reviewer for accuracy and completeness. No significant discrepancies were identified.

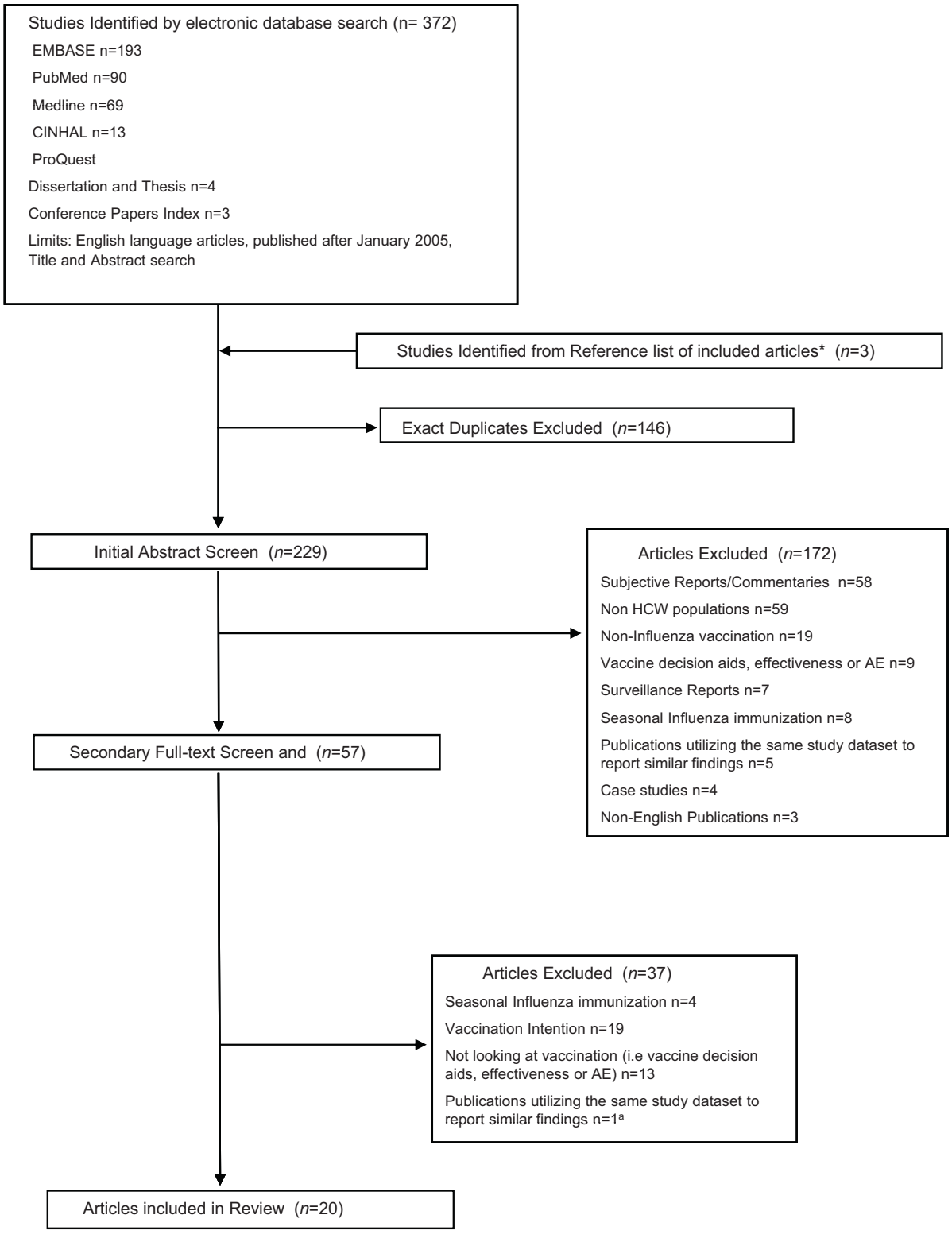
3.1. Study characteristics

20 publications consisting of 16 scientific journal articles, 2 peer-reviewed abstracts, 1 letter to the editor, and 1 research note are included in the review (Table 1). Of the included studies, 3 were conducted in North America, 7 in Europe, 7 in Middle Eastern regions, 1 in China, and 2 studies investigated pH1N1 vaccine uptake among HCW of different regions. In these two studies, Blasi et al. sampled HCW belonging to international scientific group and Chor et al. sampled HCW groups from the United Kingdom, Singapore, and Hong Kong [19,20]. Although the exact definition of HCW varied between studies, most study populations were found to be representative of staff in hospital care settings (clinical and nonclinical staff) with and without direct patient contact. A study by Amodio et al. specifically focused on post-graduate medical residents from an Italian university hospital, while Opstelten et al. surveyed Dutch general practitioners [21,22].

This review focused on actual vaccination uptake/rejection rather than the intention to be vaccinated. Therefore all of the studies included in the review were conducted after the launch of 2009/2010 pH1N1 immunization campaigns in each respective HCW population. The data collection periods of interest range from October 2009 to August 2010. The majority of studies relied on self-reported immunization status of HCW participants. Only the studies by Kraut et al. and Corace et al., both of which were conducted in Canada, report the verification of self-reported immunization status with administrative pandemic vaccination records [23,24]. Overall pH1N1 vaccination rates were found to be highly variable across study samples, ranging from 9% to 92%. Key factors reported to be predictive of pandemic vaccine uptake were coded into the 5 HBM constructs.

3.2. Summary of study findings

Factors reported to be influential in HCW pH1N1 immunization outcomes were coded into five major categories using the HBM constructs (Tables 2a, 2b and 2c). The total number of publications that identify these factors as being important to HCW pandemic



[a] Sanchez-Paya (article-in press) was included and replaced Villanueva-Ruiz (abstract)

Fig. 1. Overview of study selection.

influenza vaccination was tabulated and organized according to HBM constructs (Table 3).

3.2.1. Perceived barriers to pH1N1 vaccination

3.2.1.1. Pandemic vaccine safety and vaccine related adverse effect. Perceptions relating to pH1N1 vaccine safety and the risk of adverse effects resulting from vaccine uptake are the major barriers to pandemic vaccine uptake in HCW [19,20,23–33]. These concepts are the most cited reasons for HCW vaccine rejection [19,20,23–33]. For the majority of included studies, attitudes and beliefs relating to vaccine safety and vaccine related side effects demonstrate statistically significant differences among HCW who accepted vs. HCW

Table 1
Overview of study characteristics as reported within each study.

Author	Region	Study design	Data collection period	HCW population	Sample size (*n*)	H1N1 vaccine coverage
Ahmed et al., 2011[a]	Saudi Arab	Cohort study	Hajj 2010 (approx. October 2009)	HCW and security servicing Hajj Pilgrims	42	34%
Alkuwari et al., 2011[a]	Arab Emirates	Cross-sectional	March–April 2010	Nurses and Physicians	625	13%
Amodio et al., 2011[a]	Italy	Cross-sectional	September–October 2010	Post-graduate Medical Students	202	42%
Blasi et al., 2011[d]	Global	Cross-sectional	December 2009–January 2010	Medical society members	1334	65%
Chor et al., 2011[a]	Hong Kong, Singapore, and UK	Cross-sectional	January–April 2010	Physicians, Nurses and Allied HCW	2100	13% Hong Kong 36% Singapore 41% United Kingdom
Corace et al., 2011[b]	Canada	Cross-sectional	July–August 2010	All Hospital staff	3260	87.3%
Hakim et al., 2011[a]	USA	Cross-sectional	July–August 2010	All Hospital staff	2036	61%
Hidiroglu et al., 2010[a]	Turkey	Focus group	November 2009	Primary HCW	33	Variable
Kraut et al., 2011[a]	Canada	Cross-sectional	Fall 2010	All Hospital staff	2376	100%
Opstelten et al., 2010[a]	Netherlands	Cross-sectional	February 2010	GPs and GPs in training	670	92%
Prevost et al., 2010[b]	France	Cross-sectional	Not reported	Pharmacology staff	83	46%
Sanchez-Paya et al., 2011[a]	Spain	Cross-sectional	Not reported	All Hospital staff	3126	22%
Savas et al., 2010[a]	Turkey	Cross-sectional	November–December 2009	All Hospital staff	300	13%
Seale et al., 2011[a]	China	Cross-sectional	January 2010	Staff of Respiratory wards	1657	25%
Sevencan et al., 2011[a]	Turkey	Cross-sectional	November 2009	All provincial HCW	1691	35%
Stavroulopoulos et al., 2010[a]	Greece	Cross-sectional	Not reported	All Dialysis Center staff	34	9%
Tagajdid et al., 2010[c]	Morocco	Cross-sectional	January–February 2010	All Hospital staff	1002	22%
Tanguy et al., 2011[a]	France	Cross-sectional	November 2009–February 2010	All Hospital staff	532	36%
Torun et al., 2010[a]	Turkey	Cross-sectional	December 2009	All Hospital staff	718	23%
Virseda et al., 2010[a]	Spain	Cross-sectional	October 2010	All Hospital staff	527	16%

[a] Scientific Journal Publication.
[b] Conference Abstract.
[c] Letter to the editor.
[d] Research Note.

who refused the vaccine. A study by Torun et al. reports 81.3% vaccine acceptors believed that the pandemic vaccine was safe while only 33.9% of vaccine rejecters agreed with the same statement [33]. Similarly, Alkuwari et al. found a higher proportion of vaccine rejecters (49.5%) worry that adverse effect reports about the pH1N1 vaccine are accurate, in comparison to vaccine acceptors (24%) [25]. Additionally, HCW groups who refused the vaccine either overestimated or did not know the true incidence of pandemic vaccine related adverse events like Guillain-Barré, when compared to HCW who accepted the vaccine [20]. A study by Savas et al. measured HCW anxiety during the 2009/2010 pandemic vaccine campaign using the STAI (State Trait Anxiety Inventory) questionnaire [28].

Table 2a
Factors reported to be important in HCW pandemic influenza vaccination based on Health Belief Model (HBM) constructs.

	Ahmed et al.	Alkuwari et al.	Amodio et al.	Blasi et al.	Chor et al.	Corace et al.	Hakim et al.
Perceived barriers							
Vaccine safety		*				*	
Vaccine related adverse effects		*		*	*		*
Vaccine was developed rapidly				*			
Vaccine effectiveness or efficacy		*					
Perceived benefits							
Vaccine will protect self		*				*	*
Vaccine will protect loved ones					*	*	*
Vaccine will protect patients						*	*
Perceived susceptibility							
Risk of pH1N1 infection		*	*		*	*	
Immunity via previous exposure				*			
Perceived severity							
Seriousness of pH1N1		*		*			
Cues to action							
Mass media	*						
Access of scientific information							
Public health authorities		*	*	*			
Physicians		*					*
Co-workers and supervisors						*	*
Political/public figures							
Loved ones		*					*

Table 2b
Factors reported to be important in HCW pandemic influenza vaccination based on Health Belief Model (HBM) constructs.

	Hidiroglu et al.	Kraut et al.	Opstelten et al.	Prevost et al.	Sanchez-Paya et al.	Savas et al.	Seale et al.
Perceived barriers							
Vaccine safety						*	
Vaccine related adverse effects		*		*		*	*
Vaccine was developed rapidly	*			*			*
Vaccine effectiveness or efficacy		*				*	*
Perceived benefits							
Vaccine will protect self		*	*		*		
Vaccine will protect loved ones		*		*	*		
Vaccine will protect patients		*	*		*		
Perceived susceptibility							
Risk of pH1N1 infection	*	*					*
Immunity via previous exposure			*				
Perceived severity							
Seriousness of pH1N1	*	*		*		*	*
Cues to action							
Mass media	*					*	
Access of scientific information	*						
Public health authorities	*			*			
Physicians							
Co-workers and supervisors		*					
Political/public figures						*	
Loved ones							

This study found state anxiety levels, a measure of anxiety at the moment of scoring, to be higher among HCW who assumed the vaccine to be unsafe [28]. Such levels of anxiety were also found to be significantly higher among HCW who did not rely on the pandemic vaccine and therefore rejected the vaccine [28].

3.2.1.2. Rapidity of pandemic vaccine development. The perception that an accelerated pandemic vaccine authorization process lead to compromises in vaccine safety emerges as another key barrier to vaccine refusal in a number of studies [19,27,29–31,34,35]. A qualitative, focused group based study by Hidiroglu et al. finds that some HCW felt the pandemic vaccine underwent an accelerated testing and authorization processes to ensure timely vaccine allocation [34]. The belief of rapid vaccine development was also resonate within an international sample of HCW, who also report that the rate at which the pH1N1 vaccine was developed was too quick and cite this to be a major reason for not having pH1N1 vaccination [19]. In this study, perceptions of speedy vaccine development are reported to be a major reason for pandemic vaccine rejection as frequently as concerns regarding vaccine related side effects [19].

3.2.1.3. Pandemic vaccine will NOT be effective or efficacious. Perceptions of pandemic influenza vaccination not being an adequate mode of preventing H1N1 infections or protecting against H1N1 infections are additional barriers to vaccine uptake [24,25,28–30,33,36]. Many HCW groups report limited vaccine efficacy or vaccine effectiveness as one of their major reasons for vaccine rejection [24,25,28–30,33,36]. Alkuwari et al. states 53% of unvaccinated HCW reported doubts about the pandemic vaccine to be a major reason for vaccine rejection and vaccine effectiveness is report to be a concern among 72.6% of unvaccinated participants [25]. This study also finds HCW workers who disagreed about

Table 2c
Factors reported to be important in HCW pandemic influenza vaccination based on Health Belief Model (HBM) constructs.

	Sevencan et al.	Stavroulopoulos et al.	Tagajdid et al.	Tanguy et al.	Torun et al.	Virseda et al.
Perceived barriers						
Vaccine safety	*			*	*	
Vaccine related adverse effects	*		*	*	*	
Vaccine was developed rapidly	*	*	*			
Vaccine effectiveness or efficacy	*				*	*
Perceived benefits						
Vaccine will protect self	*			*		*
Vaccine will protect loved ones				*		
Vaccine will protect patients				*	*	*
Perceived susceptibility						
Risk of pH1N1 infection	*				*	
Immunity via previous exposure						
Perceived severity						
Seriousness of pH1N1	*	*				
Cues to action						
Mass media	*		*		*	
Access of scientific information					*	
Public health authorities					*	
Physicians						
Co-workers and supervisors						
Political/public figures					*	
Loved ones						

Table 3
The total number of publications identifying factors relevant to HCW pandemic influenza vaccination based on Health Belief Model (HBM) constructs.

Health Belief Model (HBM) constructs	Number of publications[a]
Perceived barriers	
Vaccine safety	6
Vaccine related adverse effects	11
Vaccine was developed rapidly	7
Vaccine effectiveness or efficacy	7
Perceived benefits	
Vaccine will protect self	9
Vaccine will protect loved ones	7
Vaccine will protect patients	7
Perceived susceptibility	
Risk of pH1N1 infection	9
Immunity via previous exposure	2
Perceived severity	
Seriousness of pH1N1	9
Cues to action	
Mass media	6
Access of scientific information	3
Public health authorities	6
Physicians	2
Co-workers and supervisors	3
Political/public figures	2
Loved ones	2

[a]Demonstrate statistically significant (p-value < 0.05) associations with pandemic influenza vaccination or are reported in high frequency (<30% frequency) by the study population of interest.

the pandemic vaccine's efficacy were 0.2 (0.09–0.44) times less likely to be vaccinated than HCW who agreed the pandemic vaccine was effective [25]. Studies by both Seale et al. and Torun et al. report statistically significant differences in attitudes towards vaccine effectiveness among HCW who did and did not accept the pandemic vaccine [29,33]. Savas et al. report similar finding and state that HCW who found the pandemic vaccine to be protective were 4.89 (3.19–7.50) times more likely to become vaccinated than those who did not [28]. Furthermore, 55.7% of this HCW population state not believing in the pandemic vaccine's protectiveness as a key influential factor in their decision to remain unimmunized [28].

3.2.2. Perceived benefits of pH1N1 vaccination

3.2.2.1. Pandemic vaccine will protect self. Belief in the vaccine's ability to specifically protect the HCW (self) emerges as an important benefit of vaccine uptake. Personal or self-protection from pH1N1 infection through vaccination was a popular motivator for vaccine uptake in many of the HCW samples [22–26,30,32,36,37]. Hakim et al. report 85.9% of HCW who received the pandemic vaccine agreed that the influenza vaccine will reduce their personal risk of getting sick, which was also the most commonly cited reason for pandemic vaccine uptake [26]. The perception of vaccine uptake leading to reduced personal risk of pandemic influenza infection was also reported to be an important reason for becoming vaccinated by Dutch general practitioners (GP) and GPs in training [22]. Among HCW surveyed by Virseda et al. and Sanchez Paya et al. self-protection is the most frequently mentioned reason for receiving the pandemic vaccine [36,37].

3.2.2.2. Pandemic vaccine will protect loved ones (e.g. family and friends) and colleagues. HCW who perceived the vaccine to be protective or reduce the risk of infection in not only themselves, but also among their family members and friends, or even co-workers were also more likely to become vaccinated [20,23,24,26,27,32,37]. A survey of a Pharmacology department by Prevost et al. report one of the main motivators for becoming vaccinated against pandemic influenza to be having people who are at risk of influenza in the HCWs social circle [27]. Along with pandemic vaccination uptake and rejection Kraut et al. was also interested in exploring differences in attitudes and beliefs among HCW who routinely become immunized against seasonal influenza [24]. This study finds HCW who received the pandemic vaccine cite protection of family members to be an important motivator for pandemic vaccine uptake, regardless of previous seasonal influenza vaccination history [24]. In a study which surveys HCW from three different populations in three different countries states, 25–30% of HCW from the United Kingdom and Hong Kong report they got vaccinated because they did not want to transmit the infection to others [20].

3.2.2.3. Pandemic vaccine will protect patients. Patient protection and/or patient safety though vaccine uptake is another key motivator for HCW pandemic immunization. Most vaccinated HCW recognize protection of patients from pandemic influenza as a result of their vaccination to be a benefit of becoming vaccinated [22–24,26,32,33,36,37]. For instance, Torun et al. notes the belief that HCW have a professional obligation to be vaccinated because of their role in patient care was the strongest independent predictor of vaccine acceptance in their HCW sample [33]. Virseda et al. also demonstrate patient protection to be a key reason for pandemic vaccine acceptance in another sample of hospital HCW staff [36]. Similarly GPs and GP-trainees from the Netherlands also list reduced risk to patients, reported at 82% in GPs and 88% in GP-trainees, to be their primary motive for pandemic vaccine uptake [22]. In contrast, HCW who refused the pandemic vaccine seem to be unaware of the possible health risk they pose to their patients by remaining unvaccinated [34]. Hidiroglu et al. notes that these HCW seemed to assess the need for vaccination based on individual risk and not of possible patient care benefits [34].

3.2.3. Perceived susceptibility

3.2.3.1. Risk of pH1N1 influenza infection. HCW who perceived the likelihood of pH1N1 infection to be high were more likely to become immunized against the infection, whereas HCW who perceived themselves to not be at risk of pandemic influenza infection were less likely to become immunized [20,21,23–25,29,30,33,34]. Many vaccinated HCW felt that they were at an increased risk of pH1N1 infection because of their professional role and work environment [21,24]. For instance, pH1N1 vaccinated post-graduate medical residents working in a hospital setting, were 1.38 (1.08–1.75) times more likely to consider themselves a part of a high risk group for developing influenza, in comparison to their colleagues who were not vaccinated against pH1N1 [21]. Furthermore, Torun et al. state HCW who refused the pH1N1 vaccine were most likely report being "not at all anxious" about a personal infection with pandemic influenza [33].

3.2.3.2. Immunity from pandemic influenza infection due to previous exposure. Among a few HCW groups, individuals who perceived themselves to have been previously exposed to the H1N1 virus and therefore believe they were less susceptible to re-infection were more likely to refuse immunization [19,22]. Opstelten et al. report 30% of GPs who refused the pandemic vaccine state their rationale for refusal to be the belief that they are protected against influenza as a result of frequent professional exposure to the virus [22]. An international sample of HCW also report previously having the H1N1 flu as an important reason for not being vaccinated [19].

3.2.4. Perceived severity

3.2.4.1. Severity or seriousness of pH1N1 influenza infection. HCW who perceived pH1N1 to be either a severe or a fatal infection were more likely to be vaccinated against it [25,28,30]. The belief that pH1N1 is a more serious infection than the seasonal flu was

another key factor for pandemic vaccine uptake, especially among HCW who refuse seasonal influenza immunization yet accepted the pandemic vaccine [24,27]. For example, in a group of Chinese HCW surveyed by Seale et al. stated their perceived threat of pH1N1 infection (4.6) to be the greater than that of seasonal influenza (3.2) or avian influenza (2.2) [29].

In contrast HCW who did not consider pH1N1 to be a fatal disease cited this to be a key reason for vaccine refusal [19,24,30,34,35]. According to Sevencan et al. HCW who refused the vaccine were more likely to agree H1N1 was a disease that was not as dangerous as it was proposed to have been during the pandemic [30]. While the group of HCW who participated in the focus group study are said to have assessed the severity of pandemic influenza based on the low number of pH1N1 case fatalities that were reported at the time and concluded pH1N1 was only serious among those with "poor" immune systems and pandemic influenza was not more serious than seasonal influenza [34].

3.2.5. Cues to action (i.e. situational factors)

3.2.5.1. Mass media. Many of the studies included in the review report mass media had an inhibitory effect on pH1N1 immunization in HCW [28,30,31,33,34,38]. Ahmed et al. suggested misleading media reports may have led to HCW deciding other preventative measures, such as frequent hand washing and eating citrus fruit were equally as protective as immunization [38]. These beliefs may have played a role in HCW vaccine refusal behaviour. Torun et al. also report HCW who exclusively relied on the media for pandemic influenza related information were less likely to become immunized or recommend immunization to their patients [33]. These HCW also stated media had exaggerated the pandemic influenza situation [33]. Finally, although it was not well tested among many of the HCW samples, a focus group study suggests the internet and social media may have had the capacity to act as an external cue to action among some HCW [34].

3.2.5.2. Access of scientific literature and information sources. Although media reports and media-related conspiracy theories had a negative impact on HCW vaccine uptake, evidence-based scientific literature enhanced vaccine uptake [21,33,34]. Scientific reports had a positive influence on HCW vaccine acceptability and HCW who report accessing scientific literature were more likely to have positive associations to pH1N1 immunization uptake in comparison to those who rejected the vaccine [33,34]. In addition to the reference of scientific reports, accurate knowledge about the MF59 adjuvant and its ability to enhance immunogenicity among post-graduate medical residents was also implicated in pH1N1 vaccine uptake (OR 2.06 (1.14–3.72)) [21].

3.2.5.3. Trust in public health authority communications. When compared to vaccinated HCW, HCW with the belief or attitude that the WHO over-exaggerated or over-estimated the impact of the H1N1 pandemic were 0.45 (0.21–0.97) times less likely to be vaccinated [25]. Amodio et al. find HCW who report recommendations of Health Minister/scientific sources as their main informative source for the vaccine were 4.69 (2.1–10.49) times more likely to report pandemic vaccination in comparison to HCW who do not report pandemic immunization [21]. Additionally, Sevencan et al. find HCW who had negative attitudes about the Ministry of Health's response to the pandemic and perceived pH1N1 public health responses to be inconsistent and insufficient were 0.36 times less likely to become vaccinated when compared to HCW who received the vaccine [30]. In the same study HCW who believed the Ministry of Health to have had convenient, positive, successful and reliable responses to the pandemic were 2.40 (1.89–3.04) times more likely to be vaccinated than HCW who remained unvaccinated [30].

3.2.5.4. Person based cues to action (i.e. physician, family members, supervisor, co-workers, or political figures). Immunization rates were found to be higher among HCW who believed that they were more likely to be vaccinated against pH1N1 if their doctor or loved ones (i.e. friends and family) also endorsed the pH1N1 vaccine [25,26,34].

Encouragement from individuals at a HCW place of employment, such as employer, colleagues, and supervisors, was also found to be important external cues to action [23,24,26]. Encouragement from such persons is reported to lead to more HCW receiving the pH1N1 vaccine. Corace et al. finds, that HCW who refused the vaccine were less likely to report that their supervisors and/or co-workers encouraged them to get vaccinated against the pandemic ($p < .001$) [23]. The vaccination behaviours of various workplace opinion leaders also influenced vaccine uptake decisions of other HCW [34]. Certain colleagues were deemed to be opinion leaders by fellow HCW staff if these persons were thought to have had access to the best quality and most accurate vaccine related information [34]. Interestingly, opinion leaders of physicians were usually reported to be trusted professors, while the physicians themselves became opinion leaders for other HCW in non-physician roles [34].

Political figures also had an impact on vaccination uptake decisions of some HCW samples. Specifically the Turkish Prime Minister's refusal to be vaccinated against pH1N1 was found to have had a negative impact on vaccine uptake in some Turkish HCW groups [28,33]. Savas et al., finds 40% of HCW who refused the vaccine stated they did so because of the Turkish Prime Minister's personal decision to reject the pH1N1 vaccine [28].

3.3. Other factors predictive of HCW pH1N1 immunization behaviour, not defined by the HBM

HCW pH1N1 immunization status was set to be the primary outcomes of interest and regression analysis was used to identify statistically significant predictors of vaccine uptake ($p < 0.05$), by a number of studies. These findings were explored in an attempt to identify additional socio-demographic factors which may have played an important role in HCW pandemic immunization. A total of 9 studies report the use of regression modeling techniques in data analysis. 2 of these studies were interested in modeling the intention of a HCW to be vaccinated against seasonal influenza during the upcoming influenza season [24,33]. Since this review focuses exclusively on pandemic influenza vaccine uptake as the primary outcome of interest these two reviews are not discussed further in this section.

Seasonal influenza vaccination was the most commonly cited predictor of pandemic influenza vaccination [20,25,29,33,36]. HCW who report receiving the 2009/2010 seasonal influenza vaccine or report a past history of seasonal influenza vaccination were more likely to be vaccinated against pH1N1 [20,36]. A variety of health professions/roles also demonstrated statistically significant associations with pandemic vaccination [20,29,33,36]. Specifically being a physician enhanced the likelihood of pandemic vaccine uptake, while nursing and support staff roles are reported to reduce the likelihood of pandemic vaccination [20,29,33,36]. Other variables found to demonstrate a positive effect on vaccine uptake include allowing HCW's children to be vaccinated and recommending pandemic influenza vaccination to patients [28].

4. Discussion

The overall objective of this systematic review was to examine factors that influenced pandemic influenza vaccination among

HCW groups from various geographic regions during H1N1 pandemic utilizing the HBM. We found the majority of factors relating to HCW pandemic influenza behaviour to be consistent with the HBM constructs of perceived barriers, benefits, severity, susceptibility and cues to action. In other words, HCW were more likely to become vaccinated against pandemic influenza if they: (1) believed the infection to be highly susceptible and severe, (2) believed the benefits of vaccination outweighed potential barriers, and (3) were influenced by positive cues to action. These findings further support the use of HBM as an appropriate theory for better understanding HCW influenza vaccination health behaviours in pandemic scenarios.

We also intended for this research to support the development of future influenza interventions in pandemic and non-pandemic scenarios by identifying factors both consistent with seasonal influenza vaccination and unique to pH1N1 vaccination. Our findings demonstrate many of the key factors that influenced pandemic vaccination are similar to factors determined to be important in HCW seasonal influenza vaccination by previous reviews [4,39–41]. For instance, a literature review of HCW attitudes and beliefs targeting seasonal influenza vaccination by Hofmann et al. concludes misperceptions regarding: seasonal influenza risk (i.e. susceptibility), vaccine safety and adverse effects, and the role of HCW in influenza transmission to patients to be major barriers to vaccine uptake [39]. Another review of factors predictive in HCW seasonal influenza vaccine uptake by Hollmeyer et al. finds HCW beliefs in vaccine efficacy and self-protection through immunization to be major motivators for seasonal influenza uptake [40]. Similarly to these reviews we also find HCW were more likely to become vaccinated against pH1N1 if they had a history of influenza vaccine uptake, believed the vaccine would be an efficacious mode of protection, and perceived the influenza infection to be severe [20,25,33,36]. We also find HCW who did not routinely become immunized against seasonal influenza perceived the pH1N1 vaccine to not be safe and cause adverse reactions, did not consider influenza vaccines to be either efficacious or protective and were most likely to avoid the pandemic vaccine [20,25,28,33]. These HCW also believed the pandemic was exaggerated and did not consider themselves, their patients nor loved ones to be susceptible to pH1N1 infections [22–26]. Therefore both seasonal and pandemic influenza research reveals educating HCW who refuse influenza immunization about (1) the true risk of vaccine related side-effect, (2) influenza vaccine effectiveness, (3) the importance of protecting self and others through vaccine uptake, and (4) the range of serious health risks a unvaccinated HCW can pose to themselves, their loved ones and patients can improve influenza vaccine uptake.

A variety of cues to action are also found to have an important in HCW pandemic and seasonal influenza vaccination [15,39,40]. HCW vaccination behaviour is found to be influenced by numerous external cues, in both seasonal and pandemic influenza research alike [15,39,40]. In our review, we find encouragement from numerous sources, such as HCW family, colleagues, supervisors, and physicians had a positive impact on pandemic influenza vaccine uptake [24–26]. Therefore, it may be important for various positive cues to vaccination be highlighted in future influenza vaccine related interventions. Furthermore, establishing a culture of influenza vaccine promotion in the workplace, that is characterized by strong pro-immunization messaging from staff physicians, supervisors, co-workers and other opinion leaders can also enhance vaccine uptake in healthcare settings.

Along with the similarities there are a number of factors that are unique to HCW pandemic influenza behaviour. The battery of factors influencing HCW pandemic influenza vaccination did not include time or access to the vaccine. In contrast, inconvenient access and lack of time have often been reported by HCW to be important reasons for not being vaccinated against seasonal influenza [39,40]. Since this was not the case with the pandemic, it may be appropriate to assume that most HCW populations had sufficient time and access to the vaccine and logistical barriers were mitigated within pandemic vaccine campaigns. Therefore, it may be worthwhile to mimic the pandemic vaccine campaign roll-out process for future seasonal influenza campaigns to diminish accessibility and time-sensitive barriers to vaccine uptake.

The belief that the pandemic vaccine formulation was novel and rapidly developed is also unique to the pH1N1 vaccine. In fact the vast majority of HCW groups reviewed report refusing the pandemic vaccine because of perceptions linked to rapid vaccine development and rapid vaccine authorization process [19,27,29–31,34,35]. Many HCW who refused the vaccine considered the pandemic vaccine to be less safe than the seasonal vaccine and cited this to be a major barrier to vaccine uptake [19,27,29,31]. Such findings suggest that many HCW may have been confused and sceptical about the pandemic influenza vaccine development and manufacturing processes either because of limitations in available knowledge or misinformation. Improved education and clear communication of influenza vaccination development, formulation, authorization, and safety among HCW may improve future influenza vaccine coverage.

Media was found to have played an important role in pandemic vaccine refusal [28,30,31,33,34,38]. However, the inhibitory effects of mass media on HCW vaccination appears to be absent in seasonal influenza vaccination literature. Many HCW who refused the pandemic vaccine report using mass media as their primary source of information about pH1N1, and some HCW perceived the pandemic to be less severe or considered vaccination to be linked to a large number of adverse events as a result of media based communications [28,30,31,33,34,38]. Additionally, some HCW indicated that the media was responsible for over-exaggerating the occurrence and the severity of the pandemic [28,30,38]. In contract, HCW who reported accessing credible scientific literature or communications from public health authorities, as well as HCW who were accurately knowledgeable about the vaccine adjuvant and vaccine based immunogenicity was more open to pandemic vaccination [21,33,34]. HCW who used mass media to acquire information about influenza vaccination but remained unvaccinated may have accessed non-credible literature and be confused about immunization and its risks. As such, alternative strategies to enhance future influenza vaccination compliance should focus on the delivery of scientifically evidence based literature to the masses using media based communication, in order to reduce the degree of confusion and mistrust surrounding influenza immunization.

Finally, the decision of political figures to remain unimmunized operated as a negative external cue to pandemic vaccine uptake in some HCW populations [28,33]. The Turkish Prime Minister's action to reject the pandemic vaccine, which was publicized, became a key reason for many Turkish HCW refusing the vaccine [28,33,34]. So it may be important for national health authorities to pay attention to vaccine rejection decisions of public figures when they are reported in the media and promote positive role-model vaccine strategies that in contrast encourage public engagement in vaccination.

4.1. Limitations

There are limitations to this review that should also be considered when interpreting our findings. Firstly, this review is restricted to English language publications and publications written in other languages relating to HCW pH1N1 vaccination are not captured by this review. Secondly, the vast majority of studies reviewed relied on cross-sectional or questionnaire/survey based study designs and assumed self-reported vaccination status to be a true account of actual vaccination behaviour. These types of study designs can be vulnerable to a variety of bias, such as reporter and information

bias. Thirdly, in all of the included studies HCW were invited to voluntarily participate in the study by researchers and research staff. Some of these studies also recruited HCW personnel utilizing support and buy-in from healthcare institution's administration. Therefore the surveyed HCW were not random samplings with adequate response rates. This may have meant the study sample would not be a true representation of the overall study population due to selection and volunteer bias. Volunteer bias may in fact account for the low response rates observed in many studies and the discrepancies in the proportions of vaccinated and unvaccinated HCW between the study sample and the target populations. Fourthly, almost all of the factors discussed in this review were presented to participants as forced choice options for and against pandemic vaccination within surveys and questionnaires. The majority of these choice options were generated through the review of previous research in seasonal influenza vaccination and expert consultation. Thus, some of the more sensitive nuances related to HCW pandemic immunization may not have necessarily been captured.

This review focuses on overarching factors that affected pandemic vaccination uptake and refusal in a global sample of HCW. However, we did not specifically examine differences in: (1) national healthcare systems or individual healthcare institutions, (2) types of HCW roles included in the study samples, (3) geographical or community based circumstances affecting vaccination decisions of individual HCW cohorts, or (4) cultural perceptions towards influenza vaccination. As a result, variations in HCW reasons, attitudes, beliefs, and knowledge regarding pandemic influenza vaccination according to geographic location or cultural dynamics, as they relate to either the HCW population or their healthcare system, may not have been appropriately captured by the review's findings.

4.2. Conclusions

In conclusion, our review reveals that many of the factors relating to pH1N1 vaccination are comparable to factors associated with seasonal influenza vaccination. While key factors specific to pandemic influenza vaccination include, HCW misperceptions that the pandemic vaccine formulation is novel and accelerated from that of seasonal influenza and the belief that media or health authorities exaggerated the 2009/2010 pH1N1 pandemic. Additionally, the HBM can provide insight into pandemic influenza vaccination decisions and explain factors influencing pandemic vaccine uptake and refusal of HCW.

We also find that many of the factors influencing pandemic influenza vaccination to be similar across HCW samples from different geographic regions. Therefore it can be appropriate to conclude that many HCW demonstrate similar views towards pandemic influenza vaccination regardless of their geographic location and cultural-political climate.

4.3. Key learning points going forward

The key learning points to take away from this systematic review and applied to future pandemic and seasonal influenza vaccination policies, and programs are outlined below:

- Factors that improve vaccine uptake (i.e. vaccine effectiveness, patient, self, and loved one protection) must be promoted by communication campaigns.
- Educational interventions that address factors inhibiting vaccine uptake (i.e. misperceptions about vaccine development, vaccine safety, infection susceptibility and severity) should be implemented.
- Positive cues to vaccine uptake (i.e. media communications, scientifically valid literature, and physician HCW or public figures who are positive role models for vaccine uptake) must be utilized.
- Since HCW from different geographic regions share similar attitudes and beliefs about pandemic vaccination it may be worthwhile to tailor and apply successful vaccine uptake experiences of one HCW population across multiple HCW groups.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.vaccine.2012.05.018.

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