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Influenza Vaccine Hesitancy among Healthcare Workers in a Northeastern Province in Thailand: Findings of a Cross-Sectional Survey

Manash Shrestha [1,*], Penchan Pradubmook Sherer [1], Seung Chun Paek [1], Kriengkrai Prasert [2,3], Sutthinan Chawalchitiporn [4] and Prabda Praphasiri [3,*]

[1] Department of Society and Health, Faculty of Social Sciences and Humanities, Mahidol University, Nakhon Pathom 73170, Thailand
[2] Nakhon Phanom Hospital, Nakhon Phanom, Thailand
[3] Faculty of Public Health, Kasetsart University, Sakon Nakhon, Thailand
[4] Epidemiology Department, Faculty of Medicine, Thammasat University, Thailand
* Correspondence: dr.manashshrestha@gmail.com (M.S.); marxprabda2510@gmail.com (P.P.); Tel.: +9779841380643 (M.S.); +66901987722 (P.P.)

Abstract: Despite the importance of influenza vaccination for healthcare workers (HCWs), their uptake remains challenging. This study aimed to measure influenza vaccine hesitancy among HCWs in Nakhon Phanom province, Thailand. A representative cross-sectional survey was conducted at six hospitals during August – September 2020 using a self-administered questionnaire. HCWs delaying getting influenza vaccines, accepting but unsure, or refusing with doubts were categorized as hesitant. Those accepting without any doubts were classified as non-hesitant. Vaccine hesitancy determinants were identified by multivariable logistic regression analysis. A total of 338 participants (97%) completed the questionnaires; most were female nurses working at district hospitals without pre-existing chronic medical conditions. Nearly 60% of participants (197/338) exhibited influenza vaccine hesitancy, and significant factors included age above 50 years adjusted odds ratio [aOR] 3.2, 95% CI 1.3-8.5), fair knowledge of influenza/vaccination (aOR 0.4, 95% CI 0.2-0.8), and negative influence of other HCW (High level– aOR 2.3, 95% CI 1.1-4.8; Moderate level-aOR 2.1, 95% CI 1.1-4.4). Imparting updated information to the HCW combined with positive guidance from influential peers may help reduce this hesitancy.

Keywords: influenza vaccine; healthcare workers; vaccine hesitancy; Thailand

1. Introduction

Healthcare workers (HCWs) are recommended for seasonal influenza vaccines as they are at a higher risk of contracting influenza and inadvertently transmitting the virus to high-risk and vulnerable patients who may develop severe complications [1–5]. However, despite several recommendations, influenza vaccine uptake among HCWs has remained a challenge globally [6–8]. Many studies indicate that despite vaccine availability, some HCWs may be hesitant about vaccines, especially influenza vaccines, including when considering the vaccines for their children or their patients [9–11].

While the anti-vaccination movement is not a recent development [12], more people are becoming skeptical of vaccines, such that vaccine hesitancy is now considered a major threat to global health [13]. As HCW recommendations are highly influential for patients [14,15], acceptance of vaccination by HCWs themselves is, therefore, also an important determinant of influenza vaccine uptake in the populations that they serve. Addressing the concerns of HCWs may be strategically beneficial in reducing vaccine hesitancy among the general public as well [16].

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Defined as "a delay in acceptance or refusal of vaccines despite availability of vaccination services" by the World Health Organization (WHO)'s Strategic Advisory Group of Experts (SAGE), vaccine hesitancy is a behavioral phenomenon that broadens the scope of study of vaccination decision-making [17]. Vaccine-hesitant people are seen in a spectrum between those who accept vaccination without any doubts and those who reject vaccination at all costs. In their "3C" model, SAGE identified "complacency", "inconvenience in accessing vaccines", and "lack of confidence" as three key reasons for this hesitancy [17]. However, this phenomenon is dependent on the context and specific to vaccines. For example, the hesitancy to influenza vaccine may be different than to other vaccines. Therefore, SAGE supplemented the "3C" model with a vaccine hesitancy determinant matrix that included contextual, individual and group, and vaccine/vaccination-specific influences [17]. Although Paterson et al. adapted this matrix for HCW and added a few more determinants [18], it has been informed largely by research from high-income countries. Evidence from middle-income countries like Thailand has remained minimal.

In Thailand, HCWs were the first group to be recommended for yearly influenza vaccination by the Ministry of Public Health (MOPH) since 2004 [19]. Vaccination rates among Thai HCWs were self-reported to be as high as 89% in 2009 [20]. However, in 2018, regional reports showed that HCW influenza vaccine coverage had plummeted to below 30% in some regions (Department of Medical Services [DMS], MOPH). Although little is known about Thai HCW's attitudes towards influenza vaccines, there are some disconcerting pieces of evidence. A study revealed that only 60% of Thai HCWs were willing to receive the pandemic influenza A(H1N1) vaccine [21]. In 2013, more than one-third of the Thai physicians working in ante-natal care clinics were found to have doubts about influenza vaccine's safety and effectiveness, and only 25% of them routinely recommended influenza vaccines to pregnant women [22]. Another study reported that the seasonal influenza vaccine acceptance rate among medical professionals at a tertiary hospital in Bangkok was 65.4% [23]. Being the most informed group of people about the benefits of vaccines and having more access to vaccine than others, moderate acceptance and lower recommendations of influenza vaccines by Thai HCW may indicate deeper-lying cultural or personal concerns that might relate to vaccine hesitancy.

Despite being the study site of many influenza vaccine-related research in Thailand in the recent past that have actively partnered with local HCWs [24–26], the HCW uptake rate in Nakhon Phanom province was only 28% in 2018 (DMS, MOPH). Low uptake of influenza vaccines among HCWs is particularly remarkable in this border northeastern province as it is considered a "model" province for influenza vaccine research in Thailand, where vaccination rates are supposed to be higher. As Thailand's influenza vaccination policies were largely shaped by the active surveillance data from this province [27–29], we found it important to evaluate if the HCWs in the province were themselves hesitant to influenza vaccines. Therefore, the objectives of this cross-sectional survey were to identify and measure influenza vaccine hesitancy among HCWs in Nakhon Phanom province.

2. Materials and Methods

2.1. Study Design and Setting

This cross-sectional survey was part of a mixed-methods study on influenza vaccine hesitancy among healthcare workers in Nakhon Phanom province, which is located in the plateau region of northeastern Thailand, approximately 735 km from Bangkok. The province borders Lao PDR and has a total area of 5,528.88 sq. km. The province consists of 12 districts, with Muang district as the capital, along with 97 sub-districts and 1,123 villages [27]. There are 14 public hospitals in the province: one provincial general hospital, 11 community hospitals, a psychiatric hospital, and a military hospital. From 2003 to 2015, there was active surveillance of respiratory illnesses in the public hospitals of this province [27–29].

2.2. Study Population

Thai HCWs of Nakhon Phanom province were the targeted population of the study. Although the WHO defines HCW as "all people engaged in actions whose primary intent is to enhance health"

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[30], we limited HCW's definition to those who were currently working in public hospital settings in Nakhon Phanom for operational feasibility. As per a report of DMS, 1,863 registered HCWs were working in the province in 2018 (DMS, MOPH). The HCWs were broadly categorized into two groups according to the amount of patients' contact/exposure and as grouped by WHO [31]: a) Health service providers who delivered health services and came in direct contact with patients and substances such as patients' blood and other specimens, and b) Health management and support staff who assisted in the functioning of the health system without directly providing health services and as such may or may not have had direct contact with the patients. According to the nature of their work, health service providers were further sub-categorized into six groups - medical doctors, dentists, nurses, pharmacists, public health officers, and other service providers [31].

2.3. Participant Selection Criteria

Thai HCWs of both sexes (male and female) aged above 18 years, having a good command of the written and spoken Thai language, and currently working at a public hospital in Nakhon Phanom province were included in the study. HCWs who were not present in the hospital at the time of data collection and who were not willing to participate in the study voluntarily were excluded.

2.4. Sample Size and Sampling Technique

As there was no prior estimate of influenza vaccine hesitancy among Thai HCWs, a conservative proportion of 50% was taken to calculate the sample size for the survey. A sample size of 350 was calculated using the single proportion formula and a finite population correction factor in OpenEpi (www.openepi.com), assuming a Type I error of 5%, absolute precision of 7.5 percentage points, and a design effect of 2 given the cluster sampling used for the population size of 1,863 HCW in Nakhon Phanom after inflating 10% for refusal and absences.

HCWs were recruited in the survey using a two-stage cluster sampling. In the first stage, hospitals were selected as clusters to recruit 50 HCWs in each cluster (i.e., seven clusters in total). The hospitals were chosen by a systematic random sampling using probability proportional to size (PPS) of the number of HCWs. As Nakhon Phanom Provincial hospital was a large hospital, it got selected twice. Therefore, 100 HCWs were recruited from that particular hospital, and 50 HCWs were selected from five other hospitals. In the second stage, HCWs were chosen using stratified random sampling according to their professional categories and proportional distribution in each hospital. Microsoft Excel sheets were used to generate the random numbers for the sampling in both stages, as described above.

2.5. Survey Instrument and Data Collection

The survey questions were modified from the sample questions of SAGE's vaccine hesitancy determinant matrix for the Thai context to measure influenza vaccine hesitancy and its three broad determinants: contextual or sociocultural, individual/group, and influenza vaccine-specific influences [18,32]. The participants were asked to indicate their level of agreement or disagreement with the items of the constructs on a 5-point Likert scale, with '1' meaning strongly disagree and '5' strongly agree. The questionnaire took around 30-35 minutes to complete and was validated for use in the Thai context by another research project in which face validity, content validity, acceptability, and internal consistency were assessed by pilot testing among 30 HCWs in a randomly selected hospital in Bangkok.

In this survey, the questionnaire was self-administered to the HCWs who were approached through designated focal points at the six hospitals in the province, identified by the sampling technique, from August to September 2020. A total of 350 questionnaires were distributed to the participants.

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2.6. Variables and Measurement

The dependent variable of the study, influenza vaccine hesitancy, was defined as either delaying getting influenza vaccines, accepting the vaccines but being unsure, or refusing the vaccine despite seeing its value. It was measured as a binary variable (yes/no).

"Yes" meant those HCWs who displayed some form of hesitancy, and "No" meant HCWs who accepted the influenza vaccine without any doubts.

The independent variables included demographic and work characteristics. Participant's age and years of experience as HCW were first measured as continuous variables and then converted to appropriate categories. Categorical variables were sex (binary - male/female), religion, level of the hospital (Provincial/District), HCW type (Health service providers/Health management and support staff), daily exposure to patients (<1 meter/≥1 meter/no contact), education level, and self-reported presence of any pre-existing medical conditions (yes/no). Participants' knowledge of influenza and vaccination was assessed using seven items and then grouped into three categories using a modification of Bloom's original cut-off points, such that six or more correct answers (i.e. ≥80%) represented "good knowledge", four to five correct answers (i.e. 60-79%) meant "fair knowledge" and three or less correct answers (i.e. <60%) were considered as "needed improvement".

The determinants of vaccine hesitancy were measured as constructs (i.e., composite variables). Contextual factors included the negative influence of media/social media (2 items), politics/policies (2 items), pharmaceutical industry influences (2 items), and the level of trust in the health system (2 items). Individual/group influences contained constructs of experience with past vaccination (3 items), beliefs and attitudes about influenza and vaccination (3 items), vaccination as a social norm (3 items), and influence of other healthcare professionals (2 items). Influenza vaccine/vaccination-specific issues included constructs of risk/benefit (perceived, heuristic) (4 items), risk of adverse events due to vaccination (3 items), fear of painful injections (2 items), and access to vaccines in the hospital (4 items) (Table A1). Both positively and negatively worded statements were used, and the direction of negatively worded questions was reversed for data analysis. Items under each construct were averaged to create aggregated mean scores for the construct. The average scores were case-ranked and then used to divide the construct into three categories – high, moderate, and low.

2.7. Data Analysis

Descriptive statistics were first employed to provide a summary of the selected variables and study samples. The mean scores of vaccine hesitancy determinants were compared between hesitant and non-hesitant HCWs using independent t-tests. The associated factors of influenza vaccine hesitancy were identified by a series of binary logistic regression models. As the dependent variable (influenza vaccine hesitancy) was categorical, the logistic regression analysis was performed using non-hesitant HCW as the reference category. All variables showing at least some evidence of association (Type III p values <0.1 in the binary logistic regression models) were entered into a multivariable logistic regression model, adjusting hospital locations to account for clustering. Variables with significant adjusted odds ratio (aOR) in the final model were recognized as associated factors (p-value <0.05). All data analysis was conducted using SPSS version 20 (IBM Corp., Armonk, NY).

2.8. Ethical Considerations

Written informed consent was obtained from each participant before data collection. The study protocols and all related study documents were reviewed and approved by the Mahidol University - Central Institutional Review Board (MU-CIRB) (Protocol number MU-CIRB 2020/138.1606). Permission for data collection was also received from the Provincial Chief Medical Officer, Nakhon Phanom Provincial Public Health Office (ref no. 78.02/ 06115).

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3. Results

3.1. Response Rate

Out of the total 350 survey questionnaires distributed, 338 filled questionnaires were received back from the participants, implying a response rate of 96.6% (see Figure 1). The response rates varied at different hospitals, ranging from 80-100% (Table A2).

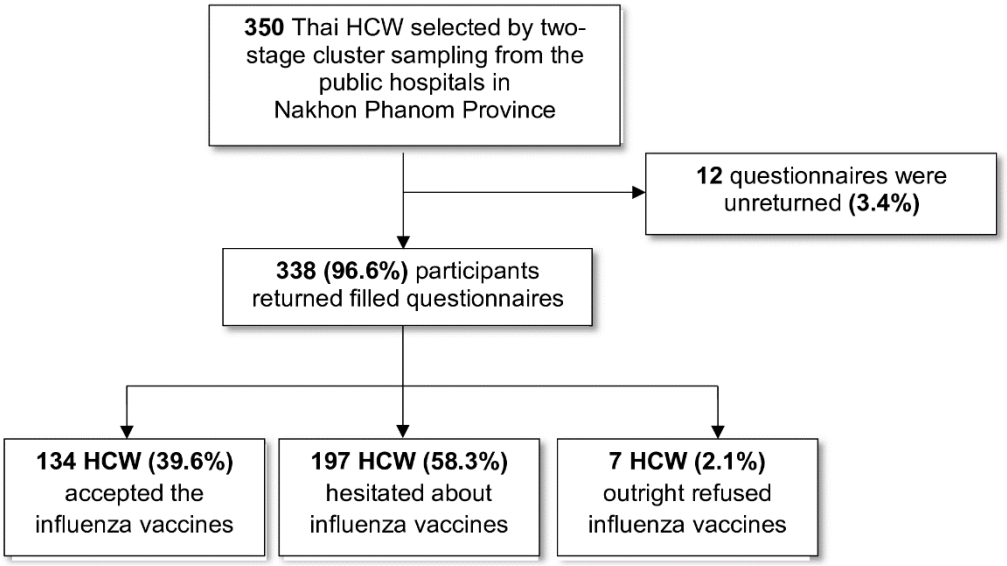

Figure 1. Study flow and influenza vaccine hesitancy among healthcare workers in Nakhon Phanom Province, Thailand.

3.2. Participant Characteristics

Of those 338 participants, the mean age was 37.2±9.7 years, with a minimum of 20 years and a maximum of 60 years. Almost all participants were Buddhists (333; 98.5%). A majority of the participants were female (280; 82.8%), nurses (136; 40.2%), from district hospitals (238; 70.7%), with bachelor's degrees (223; 65.9%), and without any pre-existing chronic medical conditions (264; 78.1%) (Table 1). The participants had a mean work experience of 13.8±9.8 years as HCW, and around half of them reported having high daily exposure with patients in the proximity of less than 1 meter (172; 50.9%).

Table 1. Participant characteristics (n=338).

Characteristic	Number	Percentage
Age group		
≤30 years	102	30.2
31-40 years	121	35.8
41-50 years	72	21.3
>50 years	43	12.7
Mean (SD): 37.2 years (9.7); Min: 20, Max: 60		
Sex		
Female	280	82.8
Male	58	17.2
Religion		
Buddhism	333	98.5
Christianity	5	1.5
Level of hospital		

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Provincial	100	29.6
District	238	70.4
HCW type		
Health service providers	295	87.3
Nurse	136	40.2
Pharmacist	19	5.6
Public health officer	19	5.6
Medical doctor	16	4.7
Dentist	6	1.8
Other medical personnel	99	29.3
Hospital assistant staff	*55*	*16.3*
Patient assistants	*27*	*8.0*
Emergency medical technicians (EMT)/paramedic	*7*	*2.1*
Laboratory staff	*7*	*2.1*
Nurse aids	*3*	*0.9*
Health management and support staff	43	12.7
Average daily exposure with patients		
High (<1 meter)	172	50.9
Moderate (1 meter or more)	106	31.4
Low (no direct patient contact)	60	17.8
Work experience as HCW		
≤5 years	74	21.9
>5 years to <20 years	166	49.1
≥20 years	98	29.0
Mean (SD): 13.8 years (9.8); Min:1, Max: 37		
Highest educational attainment		
High school or below	36	10.7
Diploma or vocational college	43	12.7
Bachelor's degree	223	65.9
Master's degree or higher	36	10.7
Pre-existing chronic medical condition		
Yes	74	21.9
No	264	78.1

Abbreviations: SD, Standard deviation; Min, Minimum; Max, Maximum.

3.3. Knowledge about Influenza and Vaccination

A high majority of HCWs were aware of the MOPH recommendation of influenza vaccination for them (302; 89.3%). However, most participants were misinformed about the influenza vaccines as only 52% correctly identified that the influenza vaccine may not work if it contained the wrong virus strains than the circulating ones, and only 30% firmly believed that the influenza vaccine does not itself cause some people to get influenza (Table 2). Overall, only a quarter of the participants had a good knowledge regarding influenza and vaccination (85; 25.1%) (Table 2).

Table 2. Participants' correct responses to each item of knowledge on influenza and vaccination (n=338).

Knowledge items	**Correct response**	**Number**	**%**
1. Healthcare workers are recommended for influenza vaccination in Thailand by the MOPH	True	302	89.3
2. Thailand has a national policy to provide free vaccine to high-risk groups	True	273	80.8

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3.	Influenza can lead to serious complications, including pneumonia	True	240	71.0
4.	HCWs are less susceptible to influenza infections than other people	False	219	64.8
5.	Influenza vaccination may not work if the vaccine contains the wrong mix of viruses	True	176	52.1
6.	Influenza vaccination does not work in some persons, even if the vaccine has the right mix of viruses	True	140	41.4
7.	Influenza vaccine may cause some people to get influenza	False	102	30.2
Overall knowledge categories				
	Need improvement (Overall score <60%)	0-3	104	30.8
	Fair (Overall score 60-79%)	4-5	149	44.1
	Good (Overall score ≥80%)	6-7	85	25.1

3.4. Influenza Vaccine Hesitancy among the Participants

A majority of the participants reported some degree of hesitancy towards influenza vaccines (197; 58.3%), and 7 HCWs (2.1%) were outright refusers of influenza vaccines who were not hesitant in their refusal (Figure 1). On closer inspection, most of the hesitant HCWs were "hesitant compliers" who had doubts about the influenza vaccines but still accepted them (172; 87.3%). Only 3 (1.5%) refused the vaccine while being considerate of its benefits, and 22 (11.2%) delayed receiving the vaccine for themselves (Figure 2). More than 60% of the health management staff, other medical professionals (paramedics), and nurses reported vaccine hesitancy, while other HCW types had less hesitancy than the sample prevalence of 58.3%; the least hesitancy was seen among pharmacists (31.6%) (Figure 3).

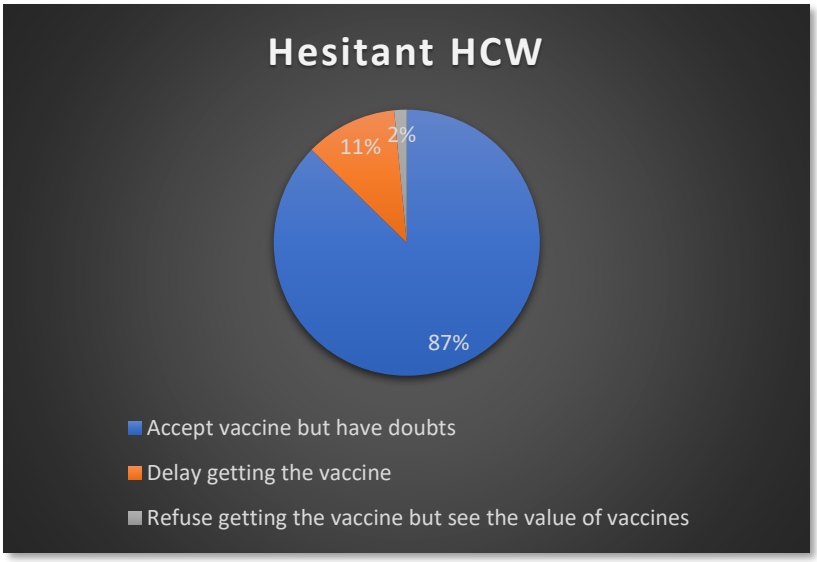

Figure 2. Types of hesitant HCW among the participants.

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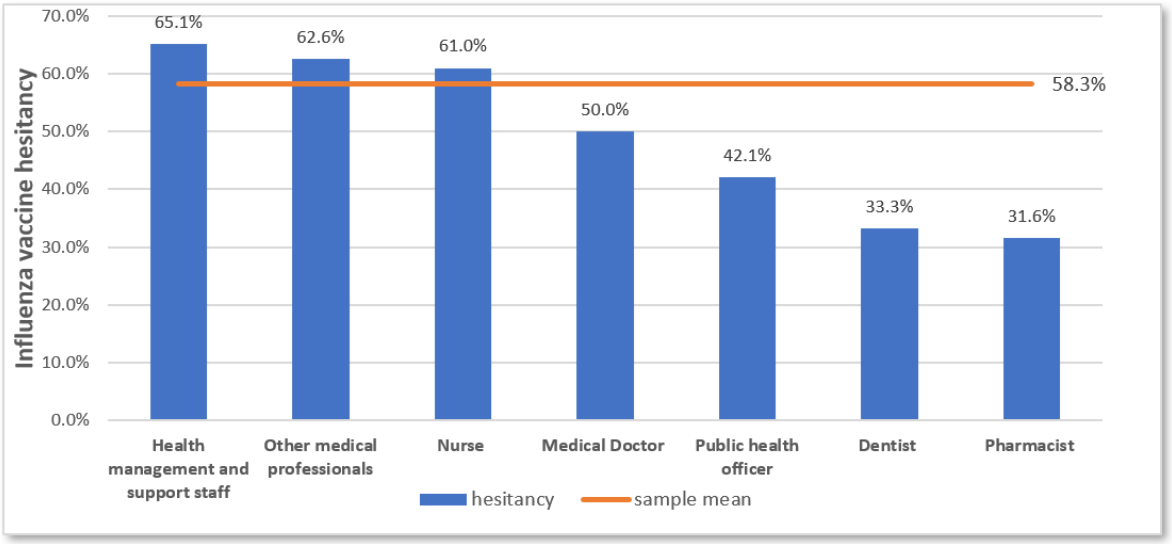

Figure 3. Influenza vaccine hesitancy levels among different HCW types.

3.5. Vaccine Hesitancy Determinants

Removing the seven HCWs who refused influenza vaccines left with an analytical sample of 331 HCWs. The aggregated mean scores and standard deviations of the vaccine hesitancy determinants are presented in Table 3. The mean scores are on a scale of 1-5, where higher scores signify higher hesitancy or more negative sentiment towards the construct. Overall, the participants reported the highest negative perceptions towards pharmaceutical industry influences (mean score 2.8, SD 1.0) and influence of media/ social media (mean score 2.7, SD 0.8) (Table 3). When the mean scores were compared, HCW with influenza vaccine hesitancy were more likely to have a higher lack of trust in the health system (2.7 vs 2.3; p-value 0.008), negative past experience of vaccination (2.4 vs 2.1; p-value 0.017), negative perception of vaccination as a social norm (2.3 vs 2.0; p-value 0.011), negative influence of other HCW (2.2 vs 1.9; p-value 0.006), higher perceived risk and lack of benefit of influenza vaccine (2.4 vs 2.1; p-value 0.001), risk of adverse events due to vaccination (2.7 vs 2.3; p-value 0.001), fear of painful injections (2.5 vs 2.2; p-value 0.007), and lack of access to vaccines (2.5 vs 2.2; p-value <0.001) (Table 3).

Table 3. Influenza vaccine hesitancy determinants aggregated mean scores (n=331).

Determinant	Total Mean (SD)	Influenza vaccine hesitancy				p-value*
		Yes (n=197)		No (n=134)		
		Mean	SD	Mean	SD	
Contextual factors						
Negative influence of media/ social media	2.7 (0.8)	2.6	0.8	2.8	0.9	0.154
Negative perception of politics/policies	1.9 (0.9)	1.9	0.8	1.8	0.9	0.057
Negative perception of pharmaceutical industry	2.8 (1.0)	2.8	0.9	2.7	1.1	0.435
Lack of trust in health system	2.5 (1.0)	2.7	0.7	2.3	1.1	0.008
Individual/Group influences						
Negative past experience of vaccination	2.3 (1.1)	2.4	1.1	2.1	1.0	0.017
Negative beliefs, attitudes about influenza and vaccination	2.2 (0.9)	2.2	0.8	2.1	1.0	0.614

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Determinant	Total Mean (SD)	Influenza vaccine hesitancy				p-value*
		Yes (n=197)		No (n=134)		
		Mean	SD	Mean	SD	
Negative perception of vaccination as a social norm	2.2 (0.9)	2.3	0.8	2.0	0.9	0.011
Negative influence of other HCW	2.0 (1.0)	2.2	0.9	1.9	1.0	0.006
Influenza vaccine specific factors						
Perceived risk of influenza infection and lack of benefit of vaccination	2.2 (0.7)	2.4	0.6	2.1	0.7	0.001
Risk of adverse events due to vaccination	2.5 (0.9)	2.7	0.9	2.3	1.0	0.001
Fear of painful injections	2.4 (0.7)	2.5	0.8	2.2	0.8	0.007
Access to vaccines in the hospital	2.4 (0.7)	2.5	0.7	2.2	0.7	<0.001

Abbreviations: SD, Standard deviation; Min, Minimum; Max, Maximum. *p-value obtained from independent t-test.

3.6. Factors Associated with Influenza Vaccine Hesitancy

In a series of univariable logistic regression analyses, different variables were found to be significantly associated with influenza vaccine hesitancy (Table 4). Compared to young HCWs (aged 30 years and below), HCWs aged above 50 years were nearly three times more likely to be vaccine-hesitant (OR 2.8; 95% CI 1.2-6.3). Similarly, HCWs with 20 years or more work experience were more than two times more likely to be vaccine-hesitant than HCWs with experience of 5 years or less (OR 2.2; 95% CI 1.2-4.2). In contrast, HCWs having fair knowledge of influenza and vaccines were less likely to be hesitant compared to HCWs with less knowledge (OR 0.5; 95% CI 0.3-0.8).

Table 4. Factors associated with vaccine hesitancy among HCW (n=331).

Factor	Influenza vaccine hesitancy		Crude OR	95% CI	Adjusted OR[a]	95% CI
	Yes (n=197)	No (n=134)				
	n (%)	n (%)				
Age-groups (in years)						
≤30	55 (53.9)	47 (46.1)	Ref		Ref	
31-40	65 (55.1)	53 (44.9)	1.0	0.6-1.8	1.1	0.6-2.1
41–50	44 (64.7)	24 (35.3)	1.6	0.8-2.9	1.9	0.9-4.1
>50	33 (76.7)	10 (23.3)	2.8	1.2-6.3*	3.2	1.3-8.5*
Sex						
Male	34 (59.6)	23 (40.4)	Ref			
Female	163 (59.5)	111 (40.5)	0.9	0.6-1.8		
Level of hospital						
Provincial	54 (55.7)	43 (44.3)	Ref			
District	143 (61.1)	91 (38.9)	1.2	0.8-2.0		
HCW type						

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Health service providers	169 (58.3)	121 (41.7)	0.6	0.3-1.3		
Health management and support staff	28 (68.3)	13 (31.7)	Ref			
Average daily patient exposure						
High	96 (56.8)	73 (43.2)	0.8	0.4-1.5		
Moderate	65 (63.1)	38 (36.9)	1.1	0.6-2.1		
Low	36 (61.0)	23 (39.0)	Ref			
Work experience						
≤5 years	37 (50.0)	37 (50.0)	Ref			
>5 years to <20 years	95 (58.3)	68 (41.7)	1.4	0.8-2.4		
≥20 years	65 (69.1)	29 (30.9)	2.2	1.2-4.2*		
Highest educational attainment						
High school or below	25 (69.4)	11 (30.6)	Ref			
Diploma/ vocational college	31 (72.1)	12 (27.9)	1.1	0.4-3.0		
Bachelor's degree	122 (56.2)	95 (43.8)	0.6	0.3-1.2		
Master's degree or higher	19 (54.3)	16 (45.7)	0.5	0.2-1.4		
Pre-existing chronic condition						
Yes	44 (60.3)	29 (29.7)	1.0	0.6-1.8		
No	153 (59.3)	105 (40.7)	Ref			
Knowledge of influenza and vaccination						
Need improvement	71 (69.6)	31 (30.4)	Ref		Ref	
Fair	74 (51.4)	70 (48.6)	0.5	0.3-0.8*	0.4	0.2-0.8*
Good	52 (61.2)	33 (38.8)	0.7	0.4-1.3	0.9	0.5-2.0
Contextual factors						
Negative influence of media/ social media						
High	41 (57.7)	30 (42.3)	0.7	0.4-1.4		
Moderate	93 (57.1)	70 (42.9)	0.7	0.4-1.2		
Low	63 (64.9)	34 (35.1)	Ref			
Negative perception of politics/policies						
High	76 (69.1)	34 (30.9)	2.6	1.5-4.7*	1.8	0.8-4.0
Moderate	78 (61.4)	49 (38.6)	1.9	1.1-3.2*	1.2	0.6-2.3
Low	43 (45.7)	51 (54.3)	Ref		Ref	

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Negative perception of pharmaceutical industry						
High	58 (65.9)	30 (34.1)	1.6	0.9-2.9		
Moderate	89 (58.6)	63 (41.4)	1.1	0.7-1.9		
Low	50 (54.9)	41 (45.1)	Ref			
Lack of trust in health system						
High	52 (69.3)	23 (30.7)	2.6	1.3-4.9*	1.3	0.5-3.5
Moderate	106 (61.3)	67 (38.7)	1.8	1.1-3.0*	1.2	0.6-2.4
Low	39 (47.0)	44 (53.0)	Ref		Ref	
Individual/group factors						
Negative past experience of vaccination						
High	65 (67.0)	32 (33.0)	2.1	1.2-3.7*	1.4	0.6-3.2
Moderate	80 (62.5)	48 (37.5)	1.7	1.0-2.9*	1.2	0.6-2.5
Low	52 (49.1)	54 (50.9)	Ref		Ref	
Negative beliefs, attitudes about influenza and vaccination						
High	62 (59.0)	43 (41.0)	1.4	0.8-2.5	0.7	0.3-1.5
Moderate	86 (67.2)	42 (32.8)	2.0	1.2-3.5*	1.4	0.7-2.7
Low	49 (50.0)	49 (50.0)	Ref		Ref	
Negative perception of vaccination as a social norm						
High	78 (68.4)	36 (31.6)	2.2	1.3-3.9*	0.9	0.4-2.3
Moderate	70 (59.3)	48 (40.7)	1.5	0.9-2.5	1.1	0.5-2.2
Low	49 (49.5)	50 (50.5)	Ref		Ref	
Negative influence of other HCW						
High	92 (70.2)	39 (29.8)	3.3	1.9-5.7*	2.3	1.1-4.8*
Moderate	60 (65.9)	31 (34.1)	2.7	1.5-4.9*	2.1	1.1-4.4*
Low	45 (41.3)	64 (58.7)	Ref		Ref	
Influenza vaccination specific factors						
Perceived risk of influenza infection and lack of benefit of vaccination						
Low	73 (68.2)	34 (31.8)	2.5	1.4-4.5*	1.0	0.4-2.5
Moderate	82 (61.7)	51 (38.3)	1.9	1.1-3.2*	0.9	0.4-1.8

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High	42 (46.2)	49 (53.8)	Ref		Ref	
Risk of adverse events due to vaccination						
High	55 (73.3)	20 (26.7)	2.8	1.5-5.3*	1.6	0.6-4.1
Moderate	84 (60.9)	54 (39.1)	1.6	0.9-2.6	0.9	0.5-1.9
Low	58 (49.2)	60 (50.8)	Ref		Ref	
Fear of painful injections						
High	104 (63.8)	59 (36.2)	1.7	1.1-2.7*	0.9	0.5-1.6
Moderate	28 (70.0)	12 (30.0)	2.3	1.0-4.8*	1.8	0.7-4.5
Low	65 (50.8)	63 (49.2)	Ref		Ref	
Access to vaccines in the hospital						
Low	64 (66.0)	33 (34.0)	2.0	1.2-3.5*	1.3	0.6-2.8
Moderate	71 (66.4)	36 (33.6)	2.1	1.2-3.5*	1.4	0.7-2.8
High	62 (48.8)	65 (51.2)	Ref		Ref	

Abbreviations: OR, Odds Ratio; CI, Confidence Interval. [a]Adjusted OR and 95% CI, and p-values calculated using multivariable logistic regression, controlling for hospital locations to account for clustering.

Among the contextual factors, HCWs with negative perceptions of politics/policies and lack of trust in the health system had significant odds of being vaccine-hesitant compared to HCWs with positive perceptions (Table 4). Similarly, in the individual/group influences, significant determinants of hesitancy were negative past experience of vaccination (High - OR 2.1, 95% CI 1.2-3.7; Moderate – OR 1.7, 95% CI 1.0-2.9), moderate level of negative beliefs (OR 2.0, 95% CI 1.2-3.5), high negative perception of vaccination as a social norm (OR 2.2, 95% CI 1.3-3.9), and negative influence of other HCW (High – OR 3.3, 95% CI 1.9-5.7; Moderate - OR 2.7, 95% CI 1.5-4.9). Among the factors specific to influenza vaccines, low perceived risk (Low - OR 2.5, 95% CI 1.4-4.45; Moderate – OR 1.9, 95% CI 1.1-3.2), high risk of adverse events after vaccination (OR 2.8, 95% CI 1.5-5.3), fear of painful injections (High – OR 1.7, 95% CI 1.1-2.7; Moderate - OR 2.3, 95% CI 1.0-4.8), and reduced access to vaccines in the hospital (Low – OR 2.0, 95% CI 1.2-3.5; Moderate – OR 2.1, 95% CI 1.2-3.5) were significantly associated with the hesitancy.

However, in the multivariable model, only age (above 50 years – aOR 3.2, 95% CI 1.3-8.5), fair knowledge (aOR 0.4, 95% CI 0.2-0.8), and negative influence of other HCW (High – aOR 2.3, 95% CI 1.1-4.8; Moderate - aOR 2.1, 95% CI 1.1-4.4) remained significant factors of influenza vaccine hesitancy (Table 4). Work experience was not entered in the final model as it showed a high correlation with age.

4. Discussion

Influenza vaccine hesitancy was highly prevalent among the Thai HCWs in this study, as nearly 60% of the survey participants reported having some degree of hesitancy. Older age and the role of other HCWs were associated with increased hesitancy, while fair knowledge of influenza and vaccination was indicated to reduce hesitancy. The findings of this study can be used to improve local influenza vaccination policy in Thailand.

Since vaccine hesitancy studies are in their nascent stage in Thailand, there are no prior estimates of the prevalence of influenza vaccine hesitancy among the HCWs. Therefore, the proportion of 58.3% found in this study can function as a baseline figure of influenza vaccine hesitancy among Thai HCWs

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for future reference. Nevertheless, comparisons can be made with past Thai studies regarding the HCW doubts of the influenza vaccines. Nearly 50% of HCWs had some doubts about the influenza vaccine in this current study, which is higher than the 30% reported among Thai physicians in 2017 [22]. In a similar vein, the vaccine acceptance rate in this study was lower than the 65.4% reported among HCWs in a Bangkok hospital [23]. Although these comparisons are limited due to differences in study sites and the HCW definition, which was expanded to include all types of HCW working in the hospital in this study as opposed to only doctors or medical service providers in the past studies [22,23], they indicate that HCW in Nakhon Phanom may be more hesitant towards influenza vaccines than normally expected. Our result is also slightly higher compared to studies in countries such as Egypt, Hong Kong, and South Africa, where influenza vaccine hesitancy among HCWs was reported to be below 50% [33–36].

While the proportion of hesitant HCWs in this study is alarming, the proportion of HCWs who actively delayed and refused vaccination was only around 11%. Most of the hesitant HCWs were those who were skeptical of the influenza vaccine but still received the vaccination. A possible explanation for this phenomenon may be that although there isn't a mandatory vaccination for HCWs and there is a notion of HCW's choice, in reality, the HCWs often end up taking the influenza vaccines as an obligation, particularly as Nakhon Phanom is a "model" province for influenza vaccine research in Thailand where vaccination rates are supposed to be higher.

In this study, the role of other HCWs, such as the medical doctor, vaccinator nurses, or senior staff, was a significant predictor of influenza vaccine hesitancy. This is an important finding as it suggests that HCW vaccine hesitancy can be potentially reduced when HCWs, such as medical doctors and supervisors, provide positive feedback and peer support to their fellow HCWs. Medical doctors have a higher social class [37], and along with vaccinator nurses, senior HCWs have more social capital to be influential in social interactions with other HCWs in hospital settings [38]. As many studies indicate, the acceptance of influenza vaccination among this group is likely to be transferred to their HCW colleagues. For example, supervisor and physician encouragement has been found to be a key predictor of HCW vaccination [39]. The strategy of using influential HCWs and senior staff was found to improve HCW vaccination in research conducted in countries such as Spain and Canada [40,41]. Similarly, in Israel, a randomized controlled trial showed that an intervention comprising of a lecture from a family physician, in addition to e-mail reminders, and a personal approach from a key local staff (doctor or nurse), was able to increase the odds of influenza vaccination among HCW by 3.51 (95% CI 2.03-6.09) compared to the control group [42]. Our study also provides supportive evidence that increasing knowledge of influenza disease and vaccine may help to reduce hesitancy to a certain extent, particularly when combined with support from an influential senior HCW.

The social capital of senior HCWs (i.e., the capital derived from one's social position and status) may explain why the vaccine-hesitant HCWs were more likely to be older than 50 years in our study. Using Bourdieu's concept of social capital [43], it can be hypothesized that when this group of experienced and senior HCWs becomes influenza vaccine-hesitant, they can exert their power to either resist (i.e., refuse) or negotiate (i.e., delay) taking vaccines. Hesitant HCWs of this group may have more options instead of being confined to the government vaccines and thus have more power to choose. In previous research, vaccine hesitancy was viewed as a form of symbolic capital that helped to understand and elaborate on the social processes, uncertainties, and difficulties in various vaccine-related journeys [44]. While in this study, the older HCW's accrued social capital with the virtue of their seniority and social networks built in the hospital for many years may have provided them with more power to resist the vaccination policy and the approaches of junior vaccinators. The higher social standing of the older HCWs may be the reason why they could overtly display their hesitancy, while the younger HCWs may have had to keep it hidden. This hypothesis, however, needs to be further explored and corroborated by other studies.

Overall, this study contributes to the growing literature on vaccine hesitancy and presents the situation of HCWs in a rural northeastern province in Thailand. This study has been reported here in accordance with the STROBE statement on cross-sectional studies (Table A3). Nevertheless, there are

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some limitations in the study. First, the research was conducted after Thailand's first wave of coronavirus disease 2019 (COVID-19). This presented different logistic hurdles and time delays in conducting the survey. More importantly, the emergence of COVID-19 might have affected some HCWs' influenza vaccine decision-making, which was not captured in the survey data as the questionnaire was designed in the pre-COVID period. Second, there may have been a potential selection bias as the data was collected exclusively in the daytime, and the HCWs working night shifts were unable to be included. Although stratified random sampling was used in the survey, which accounted for all staff working in the hospital and gave the HCW working at night time an equal probability to get enrolled, cross-sectional data collection in the daytime may have limited their participation. Finally, a small number of samples in some HCW categories reduced the statistical power of the survey to draw valid comparisons between the HCW types. Nonetheless, the survey provided a representative sample of HCWs of the province selected by a multistage cluster sampling using probability proportional to HCW size in the hospitals.

In conclusion, a high proportion of HCWs had some form of hesitancy towards influenza vaccines. The findings of this study can be used as a baseline to monitor the changes in the level of vaccine hesitancy of Thai HCWs in future studies. Public health strategies and interventions informed by the study findings may be more effective in reducing influenza vaccine hesitancy among Thai HCW.

Author Contributions: Conceptualization: MS PPS SCP PP; Data curation: MS KP SC; Formal analysis: MS SCP KP; Investigation: MS PPS SCP PP; Methodology: MS PPS SCP PP; Project administration: MS KP SC; Resources: KP PP; Supervision: PPS SCP PP; Validation: PPS SCP; Visualization: MS SCP PP; Writing – original draft: MS; Writing – review & editing: MS PPS SCP KP SC PP. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Mahidol University - Central Institutional Review Board (MU-CIRB) (Protocol number MU-CIRB 2020/138.1606, 16th July 2020). Permission for data collection was also received from the Provincial Chief Medical Officer, Nakhon Phanom Provincial Public Health Office (ref no. 78.02/ 06115).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from each participant before data collection to publish this paper.

Data Availability Statement: The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. HCW Influenza Vaccine Hesitancy Determinant Items (5 point Likert scale):.

Determinants	Items
a) Contextual factors:	
Influence of media/social media	• The reports in the media/ on social media have made me reconsider the choice to receive influenza vaccine. • I trust the negative rumors about vaccines in the social media or other sites in the internet.
Politics/policies	• The reports in the media/ on social media have made me reconsider the choice to receive influenza vaccine.

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	• I trust the negative rumors about vaccines in the social media or other sites in the internet.
Pharmaceutical industry influences	• I trust the motives of pharmaceutical industry. • I trust pharmaceutical companies to provide safe and effective influenza vaccines.
Trust in Health system	• I trust the information I receive about influenza vaccine. • The information on side-effects following influenza vaccination is discussed openly by the authorities.
b) Individual/group influences:	
Experience with past vaccination	• I have, at times, not accepted an influenza vaccination for myself when it was offered. • I or someone I know had a bad reaction to influenza vaccine in the past which made me reconsider getting influenza vaccine. • My experiences with pain with past immunization prevent me from being vaccinated against influenza.
Beliefs and attitudes about influenza and vaccination	• Influenza infection is needed to build natural immunity and that vaccines destroy the important natural immunity against influenza. • Influenza vaccine can overload the immune system. • There are better ways to prevent influenza infection than by an influenza vaccine.
Vaccination as a social norm	• It is important for every HCW to get the recommended influenza vaccines for themselves every year. • It's important for HCW to be vaccinated against influenza to protect those high-risk patients that cannot get vaccinated • I feel social pressure to receive an annual influenza vaccine.
Influence of other healthcare professionals	• My healthcare provider/vaccinator had ever advised that influenza vaccine was not necessary or had too many side effects. • My healthcare provider/vaccinator has hesitated to recommend or administer influenza vaccines to high-risk people due to their own doubts regarding the influenza vaccine.
c) Influenza vaccination-specific issues	
Perceived Risk/benefit	• Influenza is not a serious or severe enough disease that requires annual vaccination for prevention. • I am concerned that I might have a serious side effect from an influenza vaccine.

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	• I have decided against influenza vaccine because I think I am not at a high risk of influenza infection. • Influenza vaccine can prevent severe episodes of influenza.
Risk of adverse events due to vaccination	• Influenza vaccine is safe for myself and for other high risk groups. • There is adequate safety information regarding annual influenza vaccines. • The system in Thailand can track adverse reactions or side effects to influenza vaccinations
Fear of painful injections	• The fear of pain or fear of needles make me hesitant to receive influenza vaccine. • I trust my vaccinator can safely administer influenza vaccine to me.
Access to vaccines in the hospital	• Access to influenza vaccination easy/convenient in my hospital • There are adequate number of influenza vaccines in my hospital during vaccine campaign to cover all high-risk population in the area. • There are barriers for receiving influenza vaccine in time at my hospital. • The vaccines that I need to pay for myself are more effective than the free-of-charge vaccines provided at my hospital by the government.

Table A2. Response rates from each of the study hospitals.

Location	Expected respondents (N)	Respondents (n)	Response rate (%)
Nakhon Phanom Hospital	100	100	100.0
That Phanom Hospital	50	50	100.0
Phonsawan Hospital	50	50	100.0
Plapak Hospital	50	49	98.0
Na Kae Hospital	50	49	98.0
Wang Yang Hospital	50	40	80.0
Overall	**350**	**338**	**96.6**

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Table A3. STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies.*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2-3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	3
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	N/A
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	4
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5

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		(b) Give reasons for non-participation at each stage	5,9
		(c) Consider use of a flow diagram	5
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5-7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-13
		(*b*) Report category boundaries when continuous variables were categorized	9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*N/A: not applicable.

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