

Strategies used to improve vaccine uptake among healthcare providers: A systematic review

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ARTICLE INFO

Keywords:

Vaccine uptake
Health workforce
Public health
Prevention
Influenza vaccination

ABSTRACT

Background: Vaccination is one of the most effective available public health tools, preventing infectious diseases to safeguard public health and save millions of lives annually. However, in recent years vaccine hesitancy has increased among all populations, including healthcare workers. Healthcare providers are central to vaccination efforts due to their increased exposure to disease and vulnerable patients, and their role in patient confidence and decision-making. These decreasing uptake rates highlight a critical need to address specific barriers within this target group. This systematic review aims to explore the strategies used to improve vaccine uptake among healthcare providers.

Methods: A literature search was conducted in PubMed, EMBASE, and MEDLINE databases, alongside a grey literature search, to identify studies describing interventions to improve vaccine uptake among healthcare providers. This was followed by de-duplication and double-blinded screening processes using Rayyan. Data extraction and thematic analysis focused on categorising interventions and identifying frequencies of use, to develop recommendations for further interventions tailored to target regions.

Results: 60 studies were identified, predominantly concerning influenza vaccination. Interventions included educational initiatives, reminders, incentives, access solutions, feedback, and policy implementation. Key strategies included targeted educational lectures, posters, and pamphlets; mobile vaccination units; extended vaccination hours; and leadership engagement. The findings underscore the importance of a multifaceted approach combining educational efforts, enhanced accessibility, and motivational incentives to improve vaccination rates within the healthcare providers, especially where mandatory vaccination is controversial.

Conclusions: This review evaluates tailored strategies to enhance vaccine confidence and uptake among healthcare providers, advocating for a holistic approach that includes educational initiatives, reminder systems, incentives, improved access, feedback mechanisms, and policy enactment to effectively address hesitancy and promote public health.

Introduction

Vaccination is one of the most effective tools for preventing infectious diseases and safeguarding public health, saving millions of lives annually [1–3]. However, in recent years, vaccine hesitancy and scepticism have increasingly posed challenges to the achievement of high vaccination rates worldwide, causing low coverage rates and threatening global public health [4–6]. In fact, the World Health Organization

(WHO) named vaccine hesitancy one of the top ten threats to global health in 2019, citing vaccination as one of the most cost-effective preventive health measures and warning about the rise in incidence of diseases such as the measles in recent years [7]. Combatting vaccine hesitancy is consequently on the WHO's Immunisation 2030 agenda [8].

Healthcare workers play a pivotal role in global vaccination uptake as the key demographic administering the vaccines, in addition to the crucial part they play in shaping public opinion and confidence around

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<https://doi.org/10.1016/j.jvacx.2024.100519>

Received 18 April 2024; Received in revised form 25 June 2024; Accepted 30 June 2024

Available online 2 July 2024

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healthcare measures. Vaccinated healthcare workers are more likely to recommend and administer vaccines to their patients [9]. Furthermore, healthcare workers are often in contact with vulnerable people and are therefore at higher risk of transmitting infection with more devastating consequences, hence their own vaccination is of the utmost importance [10].

Alarming, the current trend of decreasing vaccine uptake also applies to healthcare professionals [11]. Several studies exploring contributing factors to hesitancy in this particular population found a combination of concerns. These included safety and efficacy of vaccines, consideration of oneself as unsusceptible, lack of personnel and time, and lack of knowledge about vaccines [10,12–15]. To counteract vaccine hesitancy among healthcare professionals, it is crucial to develop targeted strategies specifically tailored to this population. The primary objective of this systematic review was to map and evaluate the different strategies and interventions that have been applied to improve vaccine uptake amongst healthcare providers.

Methods

Protocol

The methodology for this systematic review was developed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Protocol guidelines. The study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the following registration ID: CRD42024511301.

Eligibility criteria

Table 1 describes the population, intervention, comparison, outcomes and study (PICOS) criteria for eligibility.

Search strategy

A literature search was run using the PubMed, EMBASE, and MEDLINE databases. Full search strategies are included in the appendix (Appendix A). Reference lists of included papers were searched for further eligible studies. A comprehensive search of grey literature sources was also undertaken to ensure a thorough examination of the topic, using relevant institutional websites and databases such as OpenGrey, GreyNet International, and Google Scholar. Search terms

Table 1
PICOS criteria for inclusion of studies.

PICOSS	Inclusion Criteria	Exclusion Criteria
Population	All healthcare workers (doctors, nurses, midwives, pharmacists, public health professionals). This also includes students of those professions.	Interventions aimed at teachers, the general public, or any other group that is not a health professional
Intervention	Articles will be included if they describe any intervention or strategies implemented with the aim of strengthening vaccine confidence and uptake among healthcare providers. This can relate to any vaccine.	General articles about vaccine confidence
Comparator	Any	
Outcomes	Change in vaccine uptake among target population	
Study design	Any primary interventional study with no restriction on study setting. Articles had to be published in English. There was no restriction on publication period.	Commentaries, opinions, letters, or review articles

used combinations of keywords related to vaccination, healthcare providers, and strategies to improve vaccine uptake within the healthcare workforce.

Study selection

Articles identified from the search were transferred to the digital platform, Rayyan, for de-duplication and double-blinded screening of articles. After removal of duplicates, titles and abstracts were screened against the inclusion criteria and outcome measures. Two reviewers screened all articles gathered from the search in a double-blind manner. After unblinding, disagreements on eligibility by the two reviewers was discussed. If this failed to lead to a consensus, a third senior author was consulted. Following this, included articles were subjected to full-text screening for final decision on eligibility for the systematic review. Grey literature sources identified through the search underwent the same screening and data extraction process as peer-reviewed articles. Titles and abstracts were screened against the inclusion criteria described above, with full-text assessment performed for potentially relevant documents.

Data extraction and analysis

Data was extracted from included studies according to a data extraction proforma on an excel spreadsheet. An initial table with demographic information was created to include an overview of each included study, describing the year of publication, country of publication, target vaccine, target population, period of data collection, and sample size. A second table thematically grouped the types of interventions along with their outcome measures.

Open and thematic coding analysis techniques were used to determine recurring themes and their relative salience [16]. These have been summarised in a qualitative overview describing the types of interventions conducted to improve vaccine uptake among healthcare providers.

Risk of bias assessment

This study aims to gain an understanding of the frequency and type of vaccination campaign strategies that have been implemented to increase vaccination uptake among healthcare workers. As an evaluation of the quality of these strategies is not within the scope of this review, a risk of bias assessment is not appropriate in this case. However, each study’s sample size can potentially be used as an indicator of its power.

Results

Literature search

The initial search came up with 3875 results after deduplication. Title and abstract screening identified 223 studies possibly eligible for inclusion. After full text screening, 46 remained to be included. Fourteen further studies were identified from citation lists, for total of 60 studies to be included in the analysis (Fig. 1).

Table 2 details the included studies. The majority looked at strategies to increase uptake of influenza vaccination (52), four studies investigated COVID-19 vaccination, two studies addressed all vaccines, and one each looked at Hepatitis B and Pertussis vaccination. As reasons for non-vaccination and therefore effective vaccination campaign strategies vary based on factors such as disease morbidity and mortality, transmission rates, and public discourse, we note that the campaign strategies described here will most directly apply to influenza and similar pathogens.

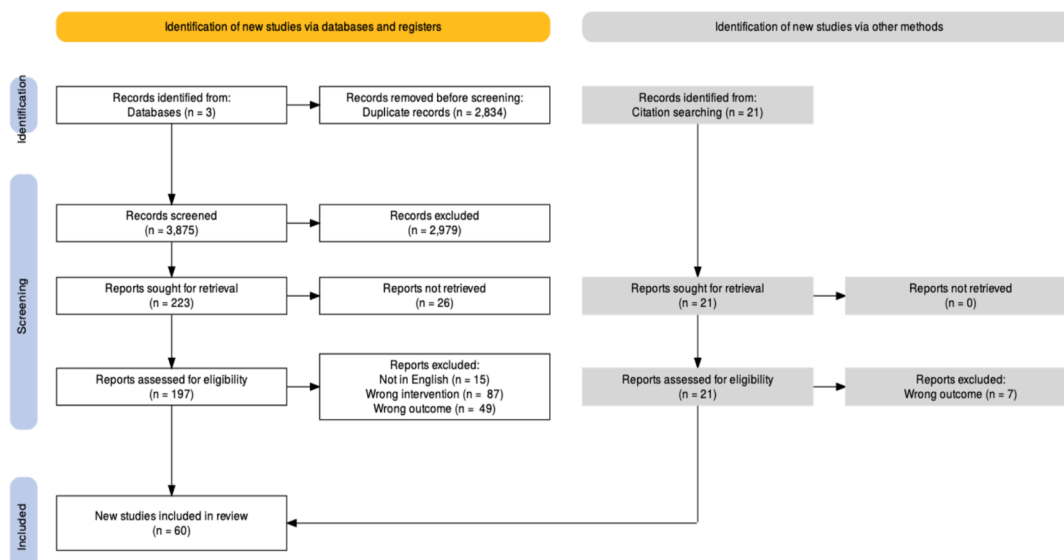


Fig. 1. PRISMA diagram.

Demographics

Fig. 2 summarises the demographics of included studies. The majority (48) came out of Europe and North America. Eight were conducted in Asian countries, three in Oceania, and one in Africa. 55 of the 60 studies were conducted in high-income countries, with only two studies from upper-middle income Turkey, one from lower-middle income Vietnam and India, and one study out of low-income Sudan.

Populations

In 32 studies, healthcare workers were subcategorised into physicians, nurses, pharmacists, and others, and the vaccination rates for those groups were analysed separately. In the remainder of the studies, all rates were analysed together. Populations were not separated by gender, ethnicity, or other demographic data.

Healthcare students

Four studies looked at strategies to increase the vaccination of healthcare students, three of which focused on medical students [18,62,25] and one on pharmacy students [75]. Targeting the healthcare profession early in their career path can be a fruitful strategy to dispel myths about vaccination and secure permanent engagement with vaccination.

Nurses

Only one study [33] looked specifically at improving uptake of vaccination among nursing personnel and is an important area for future research, as rates of vaccination in nurses have consistently been shown to be lower than in physicians [77], and their differential uptake suggests that specific and different strategies might be required to target the two groups.

Key strategies

Most studies conducted a survey prior to the design of their vaccination campaign to identify institution-specific barriers to vaccination among their staff members. Based on these results, a multi-faceted campaign strategy was introduced. The range of interventions were divided into six categories, illustrated in Fig. 3.

Table 3 displays the frequency and combination of strategies implemented across the studies, highlighting that educational lectures,

the deployment of mobile vaccination units, and the use of educational posters and pamphlets along with extended vaccination hours were the most commonly reported methods.

Education

Physical materials

Posters were the most common physical educational material, providing key messages about vaccination [68], as well as serving as reminders and occasionally including signposting information for vaccination clinics [60]. In Qatar, posters were used to show staff commitment by posting pictures of vaccinated staff members [53]. An Australian study used a short campaign slogan to improve interest in vaccination and published the slogan ‘flu-free’ on posters [20].

Where posters were often multi-use, pamphlets were distributed purely to improve educational awareness about the virus and the safety and efficacy of the vaccination itself. Pamphlets or flyers were distributed in 13 studies. These were distributed as informational leaflets, sometimes in the form of a Q&A brochure, as described in Greece [42] and the United States [41]. They were distributed to individual healthcare workers or left in common areas for perusal [64].

Two hospitals sent educational letters to healthcare workers. A Swiss study [72] focused their letter on identified misconceptions, and to corrected them in their letter. A randomized controlled trial conducted in the United States [27] involved a primary intervention group that received an educational letter detailing the importance of influenza vaccination and its benefits. This was compared to the efficacy of the normal campaign, which was composed of posters, newsletters, buttons, and educational meetings. A third group received a raffle ticket after vaccination, and the fourth group received both the educational letter and the raffle ticket. The control group had a vaccination rate of 38 %, and the group that received the educational letter only 39 % – suggesting this had little effect. The group that received both the letter and the raffle ticket had a slightly raised uptake at 44.5 %.

Virtual materials

Email was used to transmit educational messages about vaccination. One study in Spain [47] sent out a weekly email with information and advertising around influenza vaccination. A study from Qatar [53] sent emails about vaccination benefits, and an Israeli study [17] sent email reminders containing links to relevant literature. Finally, a hospital in the United States [31] sent emails with information about vaccination

Table 2
Overview of included studies.

Author	Date of publication	Country	Season/year studied	Vaccine	Sample size
Abramson et al. [17]	2010	Israel	2007–2008	Influenza	344
Afonso et al. [18]	2014	United States	2011–2012	Influenza	124
Babcock et al. [19]	2010	United States	2008–2009	Influenza	25,980
Ballestas et al. [20]	2009	Australia	2008	Influenza	6387
Barbara et al. [21]	2020	Italy	2015–2019	Influenza	4248
Butteri et al. [22]	2010	United States	2006–2007	Influenza	347
Costantino et al. [23]	2019	Italy	2015–2017	Influenza	125
De Juanes et al. [24]	2005	Spain	2001–2004	Influenza	5654
De Sarro et al. [25]	2021	Italy	2017–2020	All vaccines	804
de Vries et al. [26]	2022	Netherlands	2017	Influenza	244
Doratotaj et al. [27]	2008	United States	2004–2005	Influenza	800
Drees et al. [28]	2015	United States	2011–2015	Influenza	10,883
Esolen et al. (a) [29]	2013	United States	2009–2011	Pertussis	15,267
Esolen et al. (b) [30]	2011	United States	2009–2010	Influenza	12,363
Frisina et al. [31]	2018	United States	2014–2018	Influenza	110
Gilardi et al [Gilardi et al., 2018;15 [32]:841.	2018	Italy	2017	Influenza	2123
Golebiak et al. [33]	2020	Poland	2017	Influenza	329
Goodliffe et al. [34]	2015	Canada	2012–2013	Influenza	452
Guanche Garcell et al. [35]	2015	Qatar	2014–2015	Influenza	325
Ha et al. [36]	2020	Vietnam	2017	Influenza	18,906
Heinrich-Morrison et al. [37]	2015	Australia	2013–2014	Influenza	7480
Honda et al. [38]	2013	Japan	2012–2013	Influenza	1616
Jung et al. [39]	2017	Korea	2015	Influenza	1433
Kim et al. [40]	2021	Korea	2021	COVID-19	837
Kimura et al. [41]	2007	United States	2002	Influenza	1020
Kopsidas et al. [42]	2020	Greece	2015–2017	Influenza	363
Ksienski et al. [43]	2014	Canada	2012–2013	Influenza	48,818
Lee et al. [44]	2007	Singapore	2004–2005	Influenza	5946
Lehmann et al. [45]	2016	Netherlands	2014	Influenza	122
Leitmeyer et al. [46]	2006	Germany	2001–2003	Influenza	396
Llupia et al. [47]	2010	Spain	2008–2009	Influenza	4783
Looijmans-van den Akker et al. [48]	2010	Netherlands	2006	Influenza	3086
Madran et al. [49]	2023	Turkey	2021–2022	COVID-19	3940
Maltezou et al. [50]	2007	Greece	2005–2006	Influenza	86,765
Marshall et al. [51]	2019	Australia	2013–2018	Influenza	8944
McCullers et al. [52]	2006	United States	2004–2005	Influenza	1409
Mustafa et al. [53]	2017	Qatar	2014–2015	Influenza	7689
Oguz et al. [54]	2019	Turkey	2017–2018	Influenza	572
Pascucci et al. [55]	2023	Italy	2022	Influenza	7399
Priyadarshi et al. [56]	2022	India	2016–2021	Hepatitis B	9651
Quan et al. [57]	2012	United States	2006–2011	Influenza	6414
Rakita et al. [58]	2010	United States	2005–2010	Influenza	5024
Ribner et al. [59]	2008	United States	2006–2007	Influenza	9214
Riphagen-Dalhuisen et al. [60]	2013	Netherlands	2009–2011	Influenza	1387
Rodriguez-Fernandez et al. [61]	2016	Spain	2012–2013	Influenza	383
Saro-Buendia et al. [62]	2021	Spain	2017–2018	Influenza	965
Sartor et al. [63]	2004	France	2000–2002	Influenza	1244
Scardina et al. [64]	2021	Italy	2018–2021	Influenza	5936
Schmidtke et al. [65]	2020	United Kingdom	2018–2019	Influenza	8438
Schumacher et al. [66]	2023	Germany	2020–2021	Influenza	15,290
Smith et al. [67]	2012	United States	2011–2012	Influenza	30,048
Song et al. [68]	2006	Korea	2003–2004	Influenza	1131
Squeri et al. [69]	2017	Italy	2014–2016	Influenza	2840
Takamatsu et al. [70]	2021	Japan	2021	COVID-19	1224
Talbot et al. [71]	2021	United States	2013–2014	All vaccines	20,352
Tapiainen et al. [72]	2005	Switzerland	2004–2005	Influenza	554
Tognetto et al. [73]	2019	Italy	2017–2018	Influenza	12,226
Vimercati et al. [74]	2019	Italy	2017–2018	Influenza	700
Wedaa et al. [75]	2023	Sudan	2022	COVID-19	218
Zielonka et al. [76]	2016	Poland	2011–2012	Influenza	292

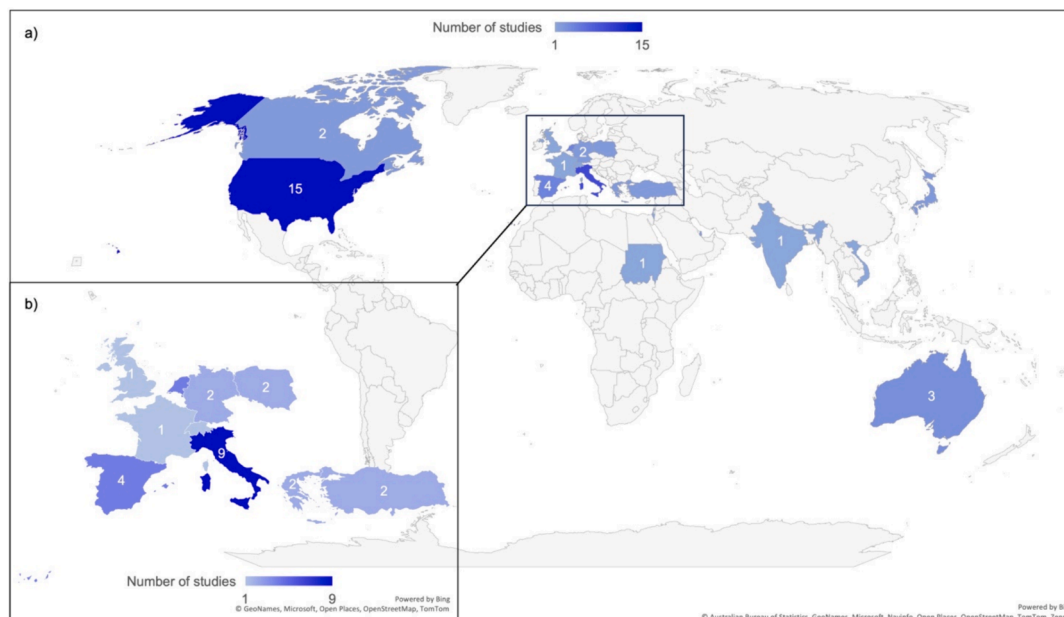


Fig. 2. Demographic overview of studies on a) a world map and b) zoomed in on Europe.

benefits, transmission, and consequences of illness.

A Spanish study [62] that focused on healthcare students employed the use of social media to share information about vaccination, and another in the Netherlands [60] posted educational quizzes on the intranet to improve education around vaccination.

Lectures

The most used strategy to improve vaccination uptake was the delivery of dedicated lectures. 26 studies from a range of countries and regions made use of lectures as a tool to educate. The format of these sessions was either didactic - a lesson given to staff members - or as group seminars, such as in a study described in Turkey [49] and another in Qatar [53]. Two studies described the use of online lectures, either through the posting of educational videos for healthcare professionals to watch [66], or as online learning modules [58].

Lectures included several key points, starting with information about the virus and infection it causes, detailing risks of transmission and complications the virus can cause. Then, sessions covered the importance of vaccination, describing the vaccine, its available forms, its safety and effectiveness, and benefits. One study from the US [18] identified the specific myths that medical students in their institution held about the vaccine and dispelled these in educational sessions. Another study out of Japan [70] ran extra sessions for healthcare workers who were pregnant or breastfeeding with more specific information. Usually, these sessions were provided to all healthcare workers, but one Korean study [39] conducted educational sessions specifically for low uptake groups of healthcare workers. A Swiss study [72] described a one-to-one intervention where head nurses initiated educational conversations with healthcare workers who were not yet vaccinated.

A group in Poland conducted a randomised controlled trial to look at the effect of lectures on vaccination uptake [33]. They divided their participants into four groups: the first received face-to-face training with an educator followed by a leaflet and a reminder to get vaccinated. The second group received the same training and leaflet but not the reminder. The two final groups underwent distance learning instead of in-person learning with an expert, and similarly both received a leaflet but only one of the two groups received the reminder. With regards to the format of the education, the first group had the highest vaccination uptake at 36.2%, compared to only 20% in the distance learning group,

suggesting in-person lectures were significantly more effective.

Various studies described educational sessions during existing staff meetings. Often, these sessions were shorter and less detailed, but were easier to facilitate using existing meeting times and structures. This saved campaign costs and time taken out of shifts. In settings where funds for vaccination campaigns are limited, this might be a preferable option.

Reminders

The most common form the reminders to vaccinate took in these studies was through email (14 studies). A study conducted in the Netherlands [45] looked at the impact of the format of email reminders, creating two randomised groups to which healthcare workers were assigned. One group was sent an email asking them to schedule an appointment if they wanted to be vaccinated – the opt-in condition – whereas the other group was sent a pre-scheduled appointment which they were asked to attend and had the option to move or cancel – the opt-out condition. The opt-out condition was more effective, leading to a 27.9% vaccination rate versus 16.4% in the opt-in group.

Six hospitals used paper letters to remind employees to be vaccinated. In Vietnam [36], hard copy registration forms were sent to healthcare workers, and in the Netherlands [60], a personal invitation letter was sent. An Australian hospital [20] sent postcards along with pay slips to mailboxes to promote vaccination, and two further studies [38,64] sent announcements to staff members' mailboxes. Finally, a randomised controlled trial conducted in the UK [65] looked at the effect of the contents of reminder letters on vaccination uptake. Staff members were randomly assigned to one of four letters. The first encouraged vaccination. The second appealed to 'descriptive norms' such as reported vaccination rates. The third appealed to 'injunctive norms', with a personalised salutation and direction to be vaccinated. The fourth combined both strategies. Interestingly, vaccination was unaffected by these different strategies.

A study out of Korea [39] sent text messages to healthcare workers to remind them to vaccinate, and two studies [65,25] used social media. One study in Vietnam [36] and another in Italy [64] used staff meetings to remind employees to get vaccinated, and this was likely also the case in hospitals that introduced dedicated lectures about vaccination. Finally, three studies used the intranet to promote vaccination

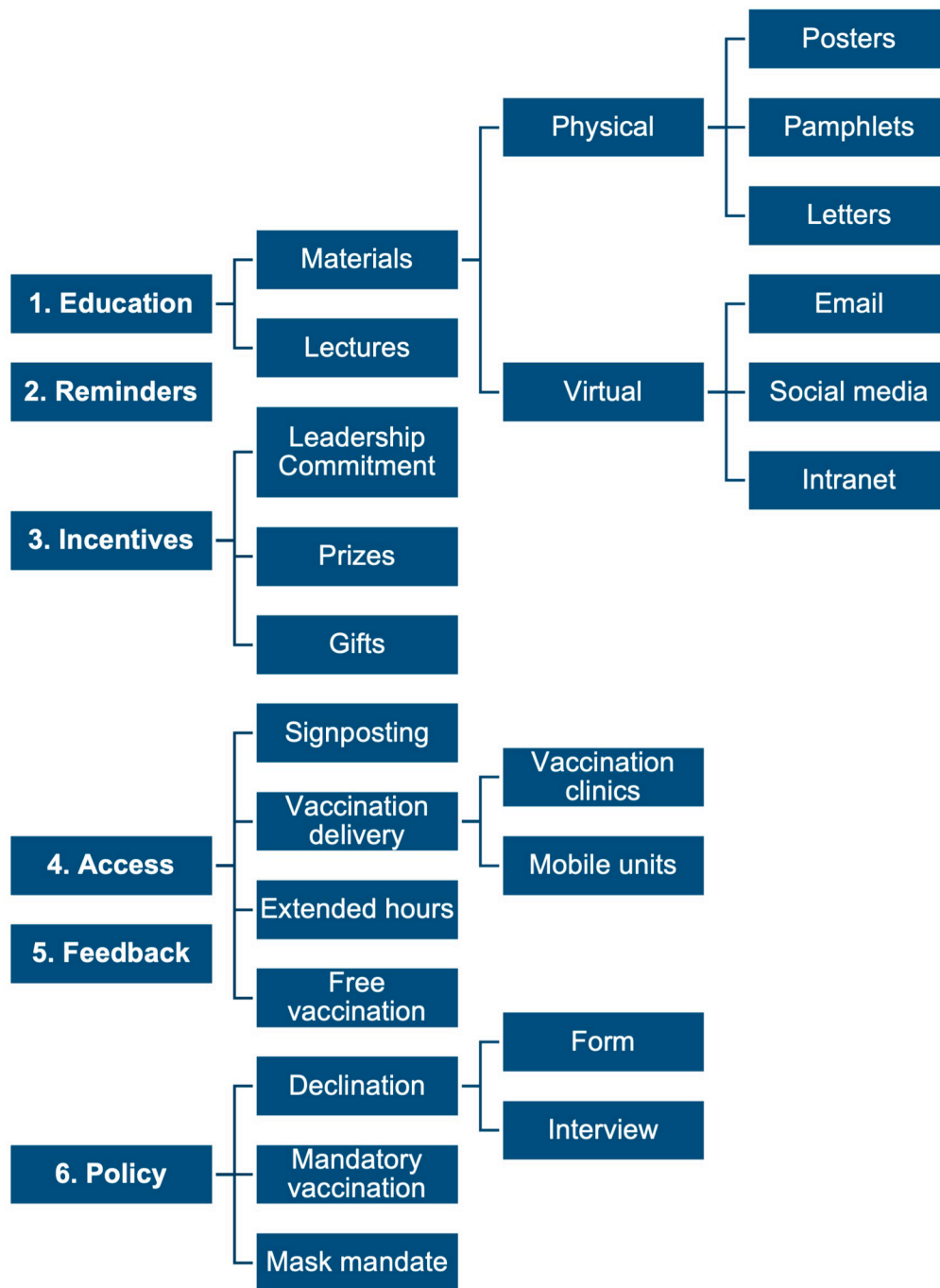


Fig. 3. Categorisation of vaccination campaign strategies.

Table 3
Campaign strategy frequency of use. For a detailed description of interventions used in each study, see Appendix 2.

Strategy			Frequency of use	
Education	Materials	Poster	20	
		Pamphlet	13	
		Letter	2	
		Email	4	
		Social media	1	
	Lessons	Intranet	1	
		Dedicated lectures	26	
		Staff meetings	7	
		Reminders	Phone/text	1
			Email	13
Letter	6			
Staff meetings	2			
Social media	2			
Incentives	Intranet	3		
	Commitment by leadership	9		
	Prizes	8		
Access	Gifts	11		
	Signposting	7		
	Mobile unit	22		
	Vaccination clinic	9		
	Free vaccination	11		
Feedback	Extended period/hours	17		
		9		
Policy	Declination	Form	9	
		Interviews	3	
	Mandatory vaccination	7		
	Mask mandate	4		

[36,70,26], with vaccination rates displayed on the intranet alongside reminders to get vaccinated.

Incentives

Commitment by leadership

Several hospitals showed their commitment to the vaccination strategy by involving leadership teams. Often, leadership figures modelled vaccine receipt [47,34]. Sometimes this occurred at a public event dedicated to the vaccination drive - such as in Italy [69], where there was an advertised 'influenza day' where managers were vaccinated. A hospital in the United States [58] threw a vaccination kick-off party, and a hospital in Germany [66] organised a flash mob displaying their campaign logo. Other hospitals [60] involved their board of directors by ensuring their presence for vaccinations, hospital management [47] made commitments to be vaccinated, or vaccination was incorporated into institutional quality goals, such as in the United States [71] and Qatar [53]. Several institutions also published (online and physical) copies of posters with pictures of vaccinated staff members [47,53,66]. These methods are important in contexts rife with mistrust in government and leadership figures.

Prizes

Prizes for vaccination were awarded on an individual or group basis. A study set in Australia [51] provided prizes to hospital wards that achieved target vaccination levels, and another [37] entered those departments that had vaccination rates over 80 % into a raffle for the chance to win a coffee maker. In Italy [32]:841 the department with the highest vaccination rate was awarded a plaque, and in the Netherlands [26], the most vaccinated department received a trophy and the department with the largest increase in vaccination received a cake. A study performed in Spain [47] introduced prize draws for those employees that had been vaccinated, with the chance to win weekend trips, dinners, a laptop, or iPods.

One group [58] gamified engagement with vaccination by creating 'flu quizzes' with prizes for winners, and hosting a 'name the campaign' contest. Another [28] provided financial incentives by using vaccination

as a factor towards the employee bonus programme. Finally, one group [27] conducted a randomised controlled trial to investigate the effect of introducing a raffle prize incentive for vaccination, finding that adding an educational letter with a raffle ticket to the normal campaign strategy consisting of posters, buttons, and meetings increased vaccination rates from 38 % to 44.5 %. Therefore, prizes can be offered on an individual or ward/department-level basis, to encourage participation, and in the department settings, help encourage employees to hold each other accountable for vaccination.

Rewards

Eleven studies described the use of gifts and freebies in their vaccination campaigns. Two studies [53,66] used these gifts as promotional objects. The German [66] study gave out stickers and buttons, where the Qatari [53] study gave away badges, pens, magnets, mugs, and key chains. Two studies, out of Australia [37] and the United States [58], provided free coffee at vaccination sites to incentivise healthcare workers to be vaccinated. The remaining studies provided a gift after vaccination. In Greece [42] and Spain [62], stickers were handed out once vaccination had been completed. Two further studies [60,32]:841 gifted pins. Others gifted badges after vaccination [28], or T-shirts [59]. Finally, an Australian study [51] gave out stickers, badges, and candy to their employees once they had been vaccinated.

Access

Signposting

Access to vaccination was improved through signposting and advertising of the date, time, and location of vaccination. In one Spanish study [61], this was shared with staff members during educational sessions about vaccination. In another, routes were publicised around the hospital to lead people to vaccination points [47], echoed in a study from the Netherlands [26] which employed the use of arrows and banners. Two studies [68,60] hung posters that shared vaccination details, and an Italian study [69] created a calendar with vaccination points. Finally, a study conducted in Greece [42] advertised their vaccination clinics for staff members to attend.

Vaccination clinics

Vaccination clinics were described in nine studies as a dedicated location in the hospital to which healthcare workers could report to be vaccinated. In India [56], the microbiology department was designated as the site for hepatitis B vaccination, increasing vaccination rates from 45.6 % to 84.2 %. A randomised controlled trial conducted in Italy [25] looked specifically at the impact of on-site vaccination on vaccination rates for all vaccines in healthcare students, by introducing a vaccination-dedicated clinic that allowed for walk-ins and free vaccination. Vaccination rates increased significantly, often to over 90 %: DTPa uptake went from 5.5 % to 96 %, HBV from 13.9 % to 95.8 %, and MenACWY from 4.9 % to 92.6 %. This suggests a significant benefit to the introduction of free ambulatory clinics for students.

Mobile vaccination units

Many studies implemented the use of mobile vaccination units in the form of carts or booths to maximise ease of vaccination. Twenty-two studies described such mobile units, and often found mobile units to be preferential to clinics. For example, in Italy [74], 80 % of vaccinated employees said they would rather be vaccinated in the working setting over having to attend a clinic. In some institutions, mobile 'carts' or 'trolleys' could be wheeled into individual departments to vaccinate healthcare workers.

One study in the United States [57] looked at the singular effect of introducing mobile vans and carts to clinical units, demonstrating an increase in vaccination rates from 44 % to 62.9 %. A study in France [63] compared their vaccination clinic in the basement to the introduction of a mobile cart, improving rates from 6-7 % to 32-35 %. In Singapore

[44], vaccination booths were replaced with vaccination carts, which allowed vaccination to come directly to the healthcare worker. This led to an increase in uptake from 61.2 % with the booths to 97 % with carts.

Other forms of mobile vaccination were storage of vaccines in nursing units for administration on the wards (US) [52] or vaccination offered at multidisciplinary team meetings (Australia) [37]. Some studies had vaccination tables or posts set up in convenient locations around the hospital, such as the cafeteria and entrances (US, Netherlands) [26,30,59]. Finally, some studies introduced vaccination teams who travelled to wards and departments to vaccinate healthcare workers locally.

Extended hours

Three studies describe in general terms the extension of vaccination hours. Two further studies extended the period of their seasonal vaccination in comparison to previous years, to help improve uptake. Four studies introduced vaccination in evenings [22,34,59,61], six during nightshifts [22,23,31,52,57,59], and six on weekends [34,37,47,57,59].

Free vaccination

Eleven studies specified that the vaccination was provided free of charge including three out of the United States [18,31,41], and one each out of Australia [51], Canada [34], India [56], Italy [25], Japan [38], the Netherlands [48], Qatar [53], and Turkey [54].

Feedback

Quan [57] described a United States study with an accessible online feedback system containing details about compliance with vaccination and producing lists of unvaccinated staff members. These lists were then directly sent to supervisors and managers. In the year that this was introduced alongside a mandatory vaccination policy, rates increased from 58.3 % to 86.7 %. Three further studies conducted in the US [28,52,59] each similarly generated lists of unvaccinated employees based on declination forms, which were sent to supervisors on a weekly or fortnightly basis for follow up. Additionally, two Qatari studies described a feedback mechanism. One [53] tracked the vaccination rates on a weekly basis and published this to encourage friendly competition between departments and hospitals, alongside the same concept as was used in the American studies, of sending non-compliance information to managers. The other study out of Qatar [35] sent an email out on a weekly basis to managers and heads of departments, with details on coverage in each department and names of those who had not been vaccinated.

An Australian study [51] created a database available through the intranet, which managers were expected to access to follow up via text message with unvaccinated staff members. A Dutch study [26] described a feedback system that also used the intranet, but the purpose of this one was to display vaccination rates of each department for everyone to access, as a 'decision information' nudge, aiming to make vaccination-relevant information salient. Finally, a study out of Spain [47] raised interest in vaccination with weekly messages about ongoing coverage rates being sent to all staff, alongside methods such as prizes and photos of vaccinated staff members to improve visibility of vaccination and provide staff members with feedback about the vaccination coverage amongst their peers to further encourage them.

Policy

Declination form

Nine studies described the use of a declination form, requiring the healthcare worker to submit a document explaining their refusal to be vaccinated. Four of those studies were conducted in the United States [18,28,57,59], two in Australia [37,51], two in Qatar [35,53], and one in Japan [38]. Declination forms are either paper-written or electronically sent and ask for the reasons for declining vaccination. An

interesting effect was seen in the group of healthcare students in the United States [18]. They were offered an educational intervention which included vaccination during that session and were asked to sign a declination form on the spot if they were unwilling to be vaccinated – asking this during the session itself seemed to lead to a sense of accountability that resulted in a vaccination rate of 100 %.

The additional advantage of declination forms is to gain a better idea of the reason that healthcare workers are refusing vaccination, producing the data that is required to personalise campaign strategies and policies to continue improving uptake among healthcare workers. Therefore, the most effective declination forms not only require employees to decline vaccination, but also ask them why they have done this – both making them consider the decision carefully and producing further data for future campaigns.

Declination interviews

Declination interviews are a discussion led by a management or leadership figure with a healthcare worker who has declined the offer of vaccination. These interviews aim to understand the reasoning behind the staff member's refusal and correct any possible misunderstandings about the vaccination. The campaign described by McCullers (US) [52] attributed their increase in vaccination from 44.7 % to 80 % to individual follow-up. Another US study [71] contacted individual employees that had not been compliant with vaccination requests to educate them, encourage vaccination, and improve accountability. A Japanese study [38] introduced medical interviews with a hospital executive, at which point unvaccinated workers were asked to either be vaccinated or submit a declination form explaining their reasons for noncompliance. In this study, all of those asked to interview agreed to be vaccinated, after citing schedule difficulties or scepticism as their reasons.

Mandatory vaccination

The most radical strategy used to encourage vaccination was that of implementing mandatory vaccination. Seven studies evaluated this method, of which five were conducted in the United States [19,30,58,67,71], and one in each India [56] and Canada [43]. All of these studies implemented mandatory vaccination at the end of a multifaceted campaign and found a significant increase in vaccination uptake with the policy change.

Mask mandate

Instead of implementing a vaccination requirement, four US studies [28,30,57,71] described the introduction of a mask mandate for all unvaccinated employees. Implementation of this policy meant unvaccinated staff members were required to wear a mask in all patient-facing interactions. This meant that staff members who were unwilling to be vaccinated were encouraged to comply with the rules to avoid having to wear a mask but without implementing a policy that forced vaccination. Alongside other interventions, these studies were all successful in further raising vaccination uptake among staff members.

Discussion

This study aimed to understand which vaccination campaign strategies have been implemented across global contexts. Educational lectures were the most widely implemented campaign strategy, followed by the introduction of mobile vaccination units, and subsequently educational posters, pamphlets, and extending vaccination hours. All five of these strategies fall into educational and access measures, concurring with results from Lam's systematic review finding that education and improving access were the most common strategies used in influenza campaigns [78].

However, we cannot take a 'one size fits all' approach. A crucial aspect of developing a successful campaign strategy is to identify the specific barriers to vaccination in each given setting and tailoring the

campaign to the results. Indeed, many of the studies included here based their campaign strategy off an initial survey sent to all healthcare workers, that identified misconceptions and barriers to vaccine uptake. We suggest that these barriers can be categorised into three overarching groups: confidence, access, and motivation.

First, vaccine confidence has been emphasised in a number of systematic reviews which have attempted to understand the aetiology of refusals to vaccinate among healthcare personnel [10,13,79]. Alongside access barriers like time constraints, costs, and lack of personnel to vaccinate, these studies most often emphasise vaccine confidence and hesitancy. In their qualitative analysis, Prieto-Campo et al identified healthcare workers' specific concerns around safety and efficacy, lack of knowledge about the vaccine, and distrust of the pharmaceutical industry [13]. The strategies that can best address these concerns around vaccine confidence are predominantly educational. As found in this study, dedicated lectures are crucial in addressing knowledge gaps and misunderstandings about infectious disease and vaccination, and tailoring educational materials to these specific misunderstandings is beneficial. Commitment by leadership can also specifically address vaccine confidence where there is distrust in health authorities and employers, as emphasised by Ahmad et al [14]. Public commitments to vaccination or being vaccinated publicly can enhance trust in these figures. Second, improved access is crucial to facilitating vaccination and is highlighted in many reviews on the topic of vaccination uptake. For example, a systematic review of Italian studies supports our findings that the adoption of a mobile clinic leads to significantly higher vaccination rates [80]. Finally, motivation plays a large role in encouraging vaccination uptake among healthcare workers, and this motivation can be encouraged through the introduction of incentives, regular feedback on vaccination rates, and the implementation of new policies surrounding vaccination, as described above.

Many papers have discussed the controversy surrounding mandatory vaccination policies. They are effective: Lam et al, who systematically reviewed the efficacy of seasonal influenza campaigns among healthcare workers found that campaigns involving regulatory components achieved higher vaccination rates than other types of interventions [78]. Similarly, Schumacher's review of influenza vaccination in healthcare workers found that mandatory vaccination often led to rates over 90 %, whereas campaigns including only education or promotion components rarely reached a 40 % coverage [81]. Finally, Hollmeyer's review of influenza campaigns also found mandatory vaccination policies to be the most effect intervention [82]. However, as both Hollmeyer and Schumacher point out, mandatory vaccination raises questions about data protection and staff autonomy [81,82]. Many healthcare workers have claimed such policies violate rights concerning their own bodies and that implementation of mandatory vaccination would alienate staff and damage morale. It could be argued that the benefits for healthcare workers and patients are worth the risks to employer-employee relationships and mandatory vaccination is therefore ethically justified, but this would vary widely by region [82].

A plausible middle ground could be the implementation of policy decisions that are less extreme than mandatory vaccination, such as mandatory declination and mask-mandates. As described above, these lead to significant increases in vaccination levels without outrightly 'forcing' vaccination on staff members. Asking healthcare workers to fill in a declination form in person – at an educational lecture for example – further enhances accountability for one's refusal to vaccinate. Lam found, for example, that vaccination coverage was highest when workers had a personal interview session [78], supporting the implementation of declination interviews. Still, in institutions where mandatory vaccination, declination, or masking are not feasible policies, multi-faceted campaigns are recommended and effective at increasing uptake [82].

Limitations

The studies included in this analysis were interventional, and studies that described interventions in theoretical terms, such as producing questionnaires to gauge acceptability of future interventions, were therefore not included. A future review could produce an overview of likely successful strategies based on these results. Most included studies were conducted in high income countries, revealing a gap in the literature around strategies used in lower- and middle-income regions. Although our inclusion of only English studies likely contributed to this, this underrepresentation was also noted by Gaviola et al, who urged for better documentation of policies and interventions attempted in these areas [83].

It is worth noting that we did not attempt to produce a judgement on efficacy of strategies, both because the efficacy of interventions will depend greatly on contextual elements and vary according to setting, time, and population – among other factors – but also because most studies described multi-component interventions without the necessary data to weigh the effect of each individual intervention. It is for these reasons that this systematic review has used a narrative approach to describe strategies and their frequencies of implementation to provide recommendations.

Conclusion

This systematic review provides examples and new data around the type and frequency of use of different campaign strategies and how these can be tailored to have a maximum positive effect in various contexts. Enhancing vaccine confidence and boosting vaccination rates among healthcare professionals necessitate a tailored, multi-dimensional campaign strategy. Hospital and health centre managers should prioritise the identification and analysis of barriers to vaccination specific to their settings. By adopting a holistic approach to vaccination campaigns—encompassing educational initiatives, reminder systems, incentives, improved access, feedback mechanisms, and, when suitable, the enactment of policies—these institutions can more effectively address hesitancy and foster a culture of vaccination.

Funding

This study was supported by a charitable donation by Pfizer. The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

CRediT authorship contribution statement

Rosaline de Koning: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mariana Gonzalez Utrilla:** Methodology, Formal analysis, Data curation, Conceptualization. **Emma Spanaus:** Writing – review & editing. **Michael Moore:** Writing – review & editing, Supervision. **Marta Lomazzi:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Marta Lomazzi reports financial support was provided by Pfizer. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A.: Search strategy

Pubmed:

(Vaccine*[tiab] OR Vaccination*[tiab] OR immuniz*[tiab] OR immunis*[tiab] OR shot*[tiab] OR jab[tiab] OR jabs[tiab] OR “Vaccines”[Mesh] OR “Immunization”[Mesh] OR “Vaccination”[Mesh]) AND (accept*[tiab] OR “adherence”[tiab] OR attitude*[tiab] OR barrier*[tiab] OR behavior*[tiab] OR “compliance”[tiab] OR “confidence”[tiab] OR concern*[tiab] OR decision*[tiab] OR distrust*[tiab] OR doubt*[tiab] OR engag*[tiab] OR fear*[tiab] OR hesita*[tiab] OR mistrust*[tiab] OR motivat*[tiab] OR “nonadherence”[tiab] OR “non-adherence”[tiab] OR “noncompliance”[tiab] OR “non-compliance”[tiab] OR reluctan*[tiab] OR refus*[tiab] OR reject*[tiab] OR trust*[tiab] OR uptak*[tiab] OR willing*[tiab] OR “Vaccination Refusal”[Mesh]) AND ((health[tiab] OR healthcare[tiab] OR “health care”[tiab] OR medical[tiab] OR clinical[tiab]) AND (personnel [tiab] OR worker*[tiab] OR provider*[tiab] OR workforce*[tiab] OR work-force*[tiab] OR staff[tiab] OR practitioner[tiab] OR practitioners[tiab] OR labor [tiab] OR labour[tiab] OR professional[tiab] OR professionals[tiab] OR trainee[tiab] OR trainees[tiab] OR intern[tiab] OR interns[tiab] OR specialist [tiab] OR “specialists”[tiab] OR student*[tiab])) OR physician*[tiab] OR doctor*[tiab] OR nurse*[tiab] OR midwi*[tiab] OR pharmacist*[tiab]) AND (strateg*[ti] OR interven*[ti] OR evaluat*[ti] OR campaign*[ti] OR approach*[ti] OR program*[ti]).

Embase:

1/ (immuni#ation* or immuni#e* or immuni#ing or vaccin*).ti,ab.
 2/ exp immunization
 3/ exp vaccination
 4/ 1 or 2 or 3.
 5/ (accept* or adherence or attitude* or barrier* or behavior* or compliance or confidence or concern* or decision* or distrust* or doubt* or engag* or fear* or hesita* or mistrust* or motivat* or nonadherence or non-adherence or noncompliance or non-compliance or reluctan* or refus* or reject* or trust* or uptak* or willing*).ti,ab.
 6/ (physician* or doctor* or practitioner* or nurse* or “healthcare worker”* or “health care worker”* or “healthcare provider”* or midwi* or pharmacist* or “public health prof”* or “health personnel”* or “medical student”* or “nursing student”* or “healthcare student”*).ti,ab.
 7/ exp health care personnel.
 8/ 6 or 7.
 9/ (strateg* or interven* or evaluat* or campaign* or approach* or program*).ti.
 10/ 4 and 5 and 8 and 9.

Medline:

1/ (immuni#ation* or immuni#e* or immuni#ing or vaccin*).ti,ab.
 2/ exp immunization
 3/ exp vaccination
 4/ 1 or 2 or 3.
 5/ (accept* or adherence or attitude* or barrier* or behavior* or compliance or confidence or concern* or decision* or distrust* or doubt* or engag* or fear* or hesita* or mistrust* or motivat* or nonadherence or non-adherence or noncompliance or non-compliance or reluctan* or refus* or reject* or trust* or uptak* or willing*).ti,ab.
 6/ (physician* or doctor* or practitioner* or nurse* or “healthcare worker”* or “health care worker”* or “healthcare provider”* or midwi* or pharmacist* or “public health prof”* or “health personnel”* or “medical student”* or “nursing student”* or “healthcare student”*).ti,ab.
 7/ exp Health personnel.
 8/ 5 or 6.
 9/ (strateg* or interven* or evaluat* or campaign* or approach* or program*).ti.
 10/ 4 and 5 and 8 and 9.

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