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REVIEW



Vaccine hesitancy in health-care providers in Western countries: a narrative review

Pierre Verger ^{a,b}, Elisabeth Botelho-Nevers ^{c,d,e,f}, Amanda Garrison^{a,b}, Dominique Gagnon^g, Arnaud Gagneur^{h,i}, Amandine Gagneux-Brunon^{c,d,e,f,j} and Eve Dubé^k

^aORS Paca, Southeastern Health Regional Observatory, Marseille, France; ^bFaculty of Medicine, Aix-Marseille University, Marseille, France; ^cDepartment of Infectious Diseases, University Hospital of Saint-Etienne, Saint-Etienne, France; ^dCIRI – Centre International de Recherche en Infectiologie, Lyon, France; ^eUniv Lyon, Jean Monnet University, Saint-Etienne, France; ^fChair PreVacCi, Presage Institut, Jean Monnet University, Saint-Etienne, France; ^gDirection des risques biologiques et de la santé au travail, Institut national de santé publique du Québec, Québec, Canada; ^hDepartment of Pediatrics, Centre de Recherche du CHUS, Québec, Canada; ⁱFaculté de médecine et des sciences de la santé, Département de pédiatrie, Université de Sherbrooke-Campus de la Santé, Québec, Canada; ^jCIC INSERM Vaccinology, University Hospital of Saint-Etienne, Saint-Etienne, France; ^kDepartment of Anthropology, Laval University, Québec, Canada

ABSTRACT

Introduction: Vaccine hesitancy (VH) is a leading cause of suboptimal vaccine uptake rates worldwide. The interaction between patients and health-care providers (HCPs) is the keystone in addressing VH. However, significant proportions of HCPs, including those who administer vaccines, are personally and professionally vaccine-hesitant.

Areas covered: This narrative review sought to characterize the nature, extent, correlates, and consequences of VH among HCPs. We included 39 quantitative and qualitative studies conducted in Western countries, published since 2015, that assessed VH among HCPs in general, for several vaccines. Studies were reviewed using the WHO 3Cs model – (lack of) confidence, complacency, and (lack of) convenience.

Expert opinion: Despite the lack of validated tools and substantial heterogeneity in the methods used to measure VH among HCPs, this review confirms its presence in this population, at frequencies that vary by country, profession type, setting, and level of medical education. Lack of knowledge and mistrust in health authorities/pharmaceutical industry/experts were among its principal drivers. Improving the content about vaccination in HCPs' training programs, facilitating access to reliable information for use during consultations, and developing and validating instruments to measure HCPs' VH and its determinants are key to addressing VH among HCPs.

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Complacency; convenience; health-care providers; review; self-vaccination; vaccine confidence; vaccine hesitancy; vaccine recommendations


1. Introduction

Although the scientific and medical consensus on vaccination's benefits is clear and unambiguous, skepticism about vaccination continues to grow in the general population [1,2], including for the new COVID-19 vaccines [3,4]. Vaccine hesitancy (VH, i.e. '[m]otivational state of being conflicted about, or opposed to, getting vaccinated; including intentions and willingness' [5]) poses a threat to the success of vaccination, as vaccination efficacy relies on high uptake, especially during the current COVID-19 pandemic [6,7]. In 2019, the World Health Organization (WHO) identified VH as one of the 10 most important issues in global health [1].

A better understanding of the dynamics and underlying issues of VH and vaccine refusal is critical to address public health concerns about vaccination. Vaccination decisions are complex, multi-dimensional, and can be vaccine-specific [8,9]. Vaccine-hesitant individuals constitute the 'middle ground' of the spectrum between those who are strongly supportive and those stridently opposed; gains in improving vaccination acceptance and uptake could be the most immediate and productive in this group.

The interaction between patients and health-care providers (HCPs) is the keystone enabling confidence in vaccination and successful reduction of VH [10,11]. Studies in high-, middle-, and limited-resource settings have consistently shown that most parents look to their child's HCP for information and advice on vaccine-preventable diseases, vaccines, and the recommended schedule [12,13]. Patients have a high level of trust in their providers, whether doctors or nurses [14]. When HCPs communicate effectively with their patients about vaccine benefits and risks, the value of and need for vaccinations, and vaccine safety, patients are more confident in their decisions. To do this well, however, HCPs must themselves be confident about the safety, effectiveness, and importance of vaccination. Previous studies have indicated that a significant proportion of HCPs, including those who administer vaccines, are vaccine-hesitant in their personal and professional lives and that various controversies may negatively influence their attitudes toward vaccines [8,15,16]. Surveys among HCPs before and at the start of the COVID-19 vaccination

CONTACT Pierre Verger  pierre.verger@inserm.fr  Faculté des sciences médicales et paramédicales, Observatoire Régional de la Santé Provence-Alpes-Côte d'Azur, 27, Bd Jean Moulin 13385, Marseille Cedex 5, France

 Supplemental data for this article can be accessed [here](#)

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Article highlights

- Vaccine hesitancy (VH), defined by the WHO 3Cs model as (lack of) confidence, complacency, and (lack of) convenience, exists among HCPs, to degrees and at frequencies that vary by country, region, setting, type of profession, and their sociodemographic and professional characteristics, such as the practice of complementary and alternative medicine (CAM);
- HCPs may be sensitive to controversy and misinformation and share with laypeople uncertainties or doubts about the benefits and safety of some vaccines;
- Complacency can also be present among HCPs who may disagree with mass vaccination strategies, or consider that children are receiving too many vaccines, or be reluctant to vaccinate older adults against diseases other than influenza and tetanus;
- The inadequacy of HCPs' training in the field of vaccination and their lack of trust in the health authorities, the pharmaceutical industry, and experts are among the principal drivers of their VH;
- As in the general population, some HCPs make a 'leap of faith' to vaccine confidence (reluctant trust);
- Shorter medical education programs are associated with higher levels of HCP VH: it is higher among nurses than physicians;
- In general, HCPs tend to favor vaccine mandates, but some consider educational strategies to be preferable;
- VH among HCPs leads to their lower vaccine uptake, a lower likelihood they will recommend various vaccines to patients, and lower self-efficacy and commitment in addressing their patients' VH.

campaigns showed that substantial numbers of HCPs did not intend or refused to receive the COVID-19 vaccine due to VH [17–19].

VH among HCPs raises concerns about vaccination in their clinical practice. Vaccine-hesitant providers cannot effectively address the concerns of their vaccine-hesitant patients. Worse, their vaccine-hesitant attitudes could exacerbate patients' concerns and doubts or even implant them. It is critically important to identify vaccine-hesitant HCPs, to understand the causes of their hesitancy, and to develop strategies tailored to addressing VH among them. Important gaps nonetheless remain in our understanding of the complex mixture of factors leading to VH among HCPs, although this comprehension is essential to designing effective targeted interventions. As with the lay public, factors leading to VH among HCPs are likely to vary between vaccines and to be context-specific, complex, and multidimensional. Providers' opinions and behaviors toward vaccines are influenced by determinants well beyond evidence and facts, including risk perceptions, trust, emotions, values, worldviews, and critical events such as outbreaks [20].

Paterson et al. published the first literature review devoted specifically to VH in HCPs [15]. It included 185 primary studies published through late October 2015 in all countries and all languages. Among them, two thirds studied HCP's own vaccination status and 17%, their knowledge, attitudes, and behaviors regarding vaccinating others. The remaining primary studies focused on various aspects of HCPs and vaccination, such as HCPs' perception of their role, their communication with parents, or interventions for increasing their own vaccine uptake. The authors concluded that knowledge about each vaccine's efficacy and safety, societal endorsement, and support from colleagues

were keys to HCPs' willingness to receive or recommend vaccination.

The aim of this narrative review is to characterize the nature, extent, and correlates of VH among HCPs in Western countries. We also assess its impact on HCPs' vaccination behaviors for themselves, their families, and their patients. We have focused this review on Western countries because of their differences with other countries in terms of the organization of health care systems, the training and roles of different HCPs, vaccine recommendation and uptake among populations, as well as social and cultural contexts.

2. Materials and methods

2.1. Database searches and article inclusion

We used the Medline and Embase databases (Ovid SP) to identify relevant studies. In consultation with a health sciences librarian, a search strategy was initially developed for Medline and then adapted for Embase (Appendix 1 in supplementary material, see last page of the document – Medline only). The database search took place on 27 May 2021. The search strategy included terms related to vaccination (vaccine, immunization, immunisation), its psychosocial determinants (knowledge, attitudes, beliefs, confidence, intentions, and behaviors) and HCP types/groups (nurses, midwives, medical students, physicians, pediatricians, and pharmacists) for articles in English and French published in the peer-reviewed literature from 2015 through the search date.

Articles were included if they met all of the following criteria: (a) focused on VH (and/or several vaccines) and assessed the psychosocial determinants of vaccine acceptance and recommendation (studies measuring only socioprofessional characteristics associated with vaccination behaviors were not included); (b) questioned HCPs or medical trainees about their willingness to recommend vaccines for themselves, their family, and/or their patients; (c) used any study design (quantitative or qualitative); (d) were conducted in one or more Western countries; (e) were peer-reviewed; and (f) their full text was available in English or in French. We excluded articles that were systematic reviews or literature reviews, conference abstracts, editorials, dissertations, commentaries, book reviews, or abstracts not accompanied by a full text, as well as articles that focused only on influenza, HPV, or COVID-19 vaccines (as various reviews have already explored them [21–26]), or that considered mainly unauthorized vaccines.

The database search generated 7,269 articles (Figure 1). After removing duplicates and reviewing titles and abstracts, we assessed eligibility for 57 full-text articles and rejected 20 that did not meet the inclusion criteria. Disagreements between authors were resolved by consensus. After the addition of two more articles from the reference lists of included articles, this review finally included 39 articles.

2.2. Article appraisal and summary

Previous studies have used various theoretical models to examine vaccination decisions among the lay public. In this

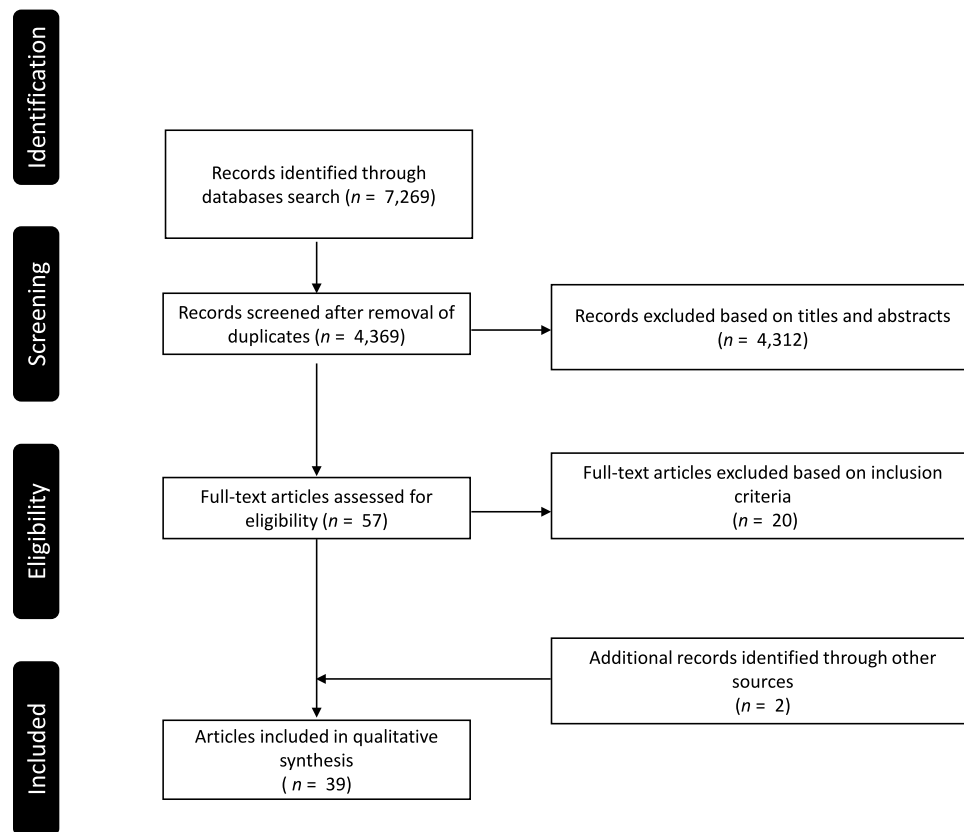


Figure 1. Steps for the selection of the articles.

review, we use the '3Cs' model to summarize the array of factors leading to VH in HCPs by its main dimensions: (lack of) confidence (in vaccine safety and efficacy and in vaccine-delivery systems), complacency (not perceiving diseases to be at high risk), and perceived (lack of) convenience (anything that facilitates access to vaccines) [27].

A data extraction form developed with Excel was used to record the included studies' characteristics. The heterogeneity of the information allowed only qualitative data synthesis.

3. Results

3.1. Characteristics of identified and included studies

This narrative review includes 39 articles published from 2015 through 2021; their characteristics are summarized in Table 1. Most of these articles (31/39, 79.5%) were from European countries [28–58]; 7 took place in North America [59–63] and Oceania [64,65], and one study included HCPs from several Spanish- and Portuguese-speaking countries in Europe and the Americas [66]. Most (24/39, 61.5%) were conducted among general practitioners (GPs)/physicians [28,29,31,32,34,36–38,40–44,49,50,52,55,57,58,60,61,63–65], either exclusively or together with other HCPs, while 14/39 (35.9%) studies included nurses [30–32,38,45–49,52,53,60,62,63], 7/39 (17.9%) medical students [32,33,35,51,54,56,59], 5/39 (12.8%) midwives [38,39,47,64,65], and 2/39 (5.1%) medical doctors providing complementary and alternative medicine (CAM) services [58,66].

Articles presented their findings in terms of 'VH' or 'vaccine confidence' (VC). Among the articles included, 22/39 (56.4%) focused particularly on VH [28–30,34,38–41,43,44,46,48,50–52,54,55,58,59,61–63]. Four articles (4/39, 10.3%) mentioned VC only and demonstrated their findings in terms of VC rather than VH [35,37,64,65]. An additional article (1/39, 2.3%) included the term 'VC' in its title, but presented its results in terms of VH (delay or denial of vaccination) [31]. Two other articles (2/39, 5.1%), without using the term VH, studied vaccine anxieties (fears about the side effects of vaccines) or the discordance between HCP recommendations and self-practice that signals VH [57,60]. Ten articles (10/39, 25.6%) made no explicit mention of either VH or VC, but measured vaccine-related attitudes and behaviors among participating HCPs [32,33,36,42,45,47,49,53,56,66].

A very substantial majority (33/39, 84.6%) of these studies used quantitative methods and collected information from HCPs through cross-sectional questionnaires [28–35,37–51,53,54,56,57,59,61,62,64–66]. Among them, 22/33 (66.7%) used multivariable regression models [28,30,32,34,35,37,38,41–44,46,48,49,53,54,64,65], structural equation modeling (SEM) [31,50], and/or multiple correspondence analysis (MCA) [29,57], along with descriptive and bivariate analyses, to present their data and results. Nine of 33 studies (27.3%) used only bivariate tests such as Chi-squared, Fisher's exact, and Spearman's or Pearson's correlation tests to analyze data [39,40,45,47,51,59,61,62,66]; and 2 more (6.1%) studies provided only descriptive results [33,56].

Table 1. Description of the included articles (n = 39).

Reference number	First Author, Published Year	Country	Data Collection Period	Vaccines Considered	Population	Sample Size (Response Rate)	Data Collection Method	Information Collected
[28]	Verger, 2015	France	April-July 2014	MMR, HBV, MenC, HPV, influenza	GPs	1712 (46%)	Cross-sectional questionnaire	Demographics, patient recommendations, perceived likelihood of serious adverse events, perceived usefulness of vaccines, general opinions towards vaccination; perceived role in vaccination
[29]	Verger, 2016	France	April-July 2014	MMR, HBV, MenC, HPV, influenza	GPs	1712 (46%)	Cross-sectional questionnaire	Demographics, patient recommendations, perceived likelihood of serious adverse events, perceived usefulness of vaccines, general opinions towards vaccination; perceived role in vaccination
[30]	Thomire, 2021	France	October 2017-February 2018	Vaccination in general	Nurses	903 (9%)	Cross-sectional questionnaire	Demographics, vaccine confidence, convenience and complacency, CAM use, trust in health institutions, self-vaccination behaviors
[31]	Karlsson, 2019	Finland	February-March 2018	Childhood vaccinations (for HCPs with children) and influenza (self-vaccination)	GPs, nurses, head nurses & practical nurses in hospitals	4286 (49%)	Cross-sectional questionnaire	Beliefs about the benefits and safety of vaccines, general trust towards other health-care professionals, personal vaccination behavior, patient recommendation behavior in cases where patients are hesitant towards vaccines
[32]	La Torre, 2017	Italy	September 2014–August 2015	Influenza, tuberculosis, MMR, varicella, pertussis, HBV	Physicians, nurses, & biomedical students	571 (93.3%)	Cross-sectional questionnaire	Demographics, knowledge, attitudes and behaviors towards vaccine-preventable diseases, perceived risks
[33]	Rostkowska, 2021	34 EU countries	March-August 2016	Vaccination in general	Medical students & junior doctors	1,821 (NS)	Cross-sectional questionnaire	General attitudes towards vaccination and sources of information, knowledge and practices, attitudes towards mandatory vaccination, vaccine status
[34]	Killian, 2016	France	October 2013-January 2014	DTP, MMR, pneumonia, HBV, HPV, seasonal and H1N1 influenza and menC	GPs	693 (12.5%)	Cross-sectional questionnaire	Vaccination behaviors for themselves and their children, patient recommendations
[35]	Salek, 2020	Czech Republic	April 2019	Vaccination in general	Medical and teacher-education students	386 (NS)	Cross-sectional questionnaire	Lifestyle factors, vaccination, fear of side effects of vaccines or infectious diseases; attitudes towards alternative medicine
[36]	Eilers, 2015	The Netherlands	May-June 2013	Influenza, varicella, pertussis, pneumonia	GPs	10 (NS)	Semi-structured interviews	Perceived role concerning prevention in general, attitudes regarding current vaccination programs, vaccines, and reasons for vaccinating or not, practices and attitudes toward vaccinating elderly populations

(Continued)

Table 1. (Continued).

Reference number	First Author, Published Year	Country	Data Collection Period	Vaccines Considered	Population	Sample Size (Response Rate)	Data Collection Method	Information Collected
[37]	Stefanoff, 2020	Poland	June–July 2017	Vaccination in general	Pediatricians and GPs	500 (19%)	Cross-sectional questionnaire	Support for vaccinations, vaccination practices for their children, vaccine status, vaccination myths
[38]	Di Martino, 2020	Italy	August–November 2019	Vaccination in general	Physicians, nurses, midwives	347 (NS)	Cross-sectional questionnaire	Attitudes and beliefs toward vaccination
[39]	Massot, 2018	France	September 2014–December 2017	Influenza and pertussis, vaccination in general	Midwives	917 (NS)	Cross-sectional questionnaire	Demographics, vaccine perception, vaccination status for mandatory and recommended vaccines
[40]	Vezzosi, 2019	Italy	October 2018	Influenza, pneumonia, varicella	GPs	73 (26.6%)	Cross-sectional questionnaire	Demographics, knowledge and attitudes toward specific vaccinations, vaccine status, experiences with patients
[41]	Tomljenovic, 2021	Croatia	July–December 2018	Vaccination in general and influenza, HPV, MMR	GPs, pediatricians, nurses	324 (65.5%)	Cross-sectional questionnaire	Vaccine safety, usefulness and necessity, perceived risks, attitudes towards mandatory vaccination, confidence in institutions and sources of information, perceived role in vaccination, knowledge
[42]	Collange, 2019	France	April–July 2014	MMR, MenC, HPV, HBV, influenza	GPs	2,586 (NS)	Cross-sectional questionnaire	Demographics, patient recommendations, vaccination coverage, confidence in authorities, safety and efficacy of vaccines
[43]	Neufeld, 2020	Germany	December 2017–January 2018	Influenza, pertussis, HBV	GPs	700 (NS)	Cross-sectional questionnaire	Vaccination status, patient recommendations, trust in institutions, sources of information, barriers to vaccination, vaccination promotion practices
[44]	Neufeld, 2021	Germany	January–March 2020	Vaccination in general and measles	Physicians	2,229 (NS)	Cross-sectional questionnaire	Demographics, attitudes toward mandatory vaccination, confidence in communicating with patients about vaccines, knowledge, patient position on vaccination
[45]	Tamburrano, 2019	Italy	2017–2018	Influenza, varicella, MMR, tuberculosis, DTP, HAV, HBV, MenC, pneumonia	Nurses and coordinating nurses	85 (NS)	Cross-sectional questionnaire	Beliefs about side effects, vaccine efficacy, patient recommendations
[46]	Elizondo-Alzola, 2021	Spain	March 2016–February 2017	Childhood vaccinations	Pediatric nurses	137 (83%)	Cross-sectional questionnaire	Demographics, perceived risks, beliefs on safety, social norms, knowledge about vaccines
[47]	Little, 2015	Great Britain	September 2013	MMR and influenza	Medical nurses, administrative staff, midwives	133 (NS)	Cross-sectional questionnaire	Demographics, vaccination history, knowledge of recommendations, reasons for lack of uptake, perceptions of vaccinations
[48]	Wilson, 2020	France	October 2017–March 2018	Mandatory and recommended vaccines for health-care workers [‡]	Nurses	1,539 (85%)	Cross-sectional questionnaire	Demographics, vaccination status, self-reported vaccine hesitancy, perceived risks of various vaccines, trust in sources of information on vaccination, confidence discussing risks and benefits of vaccines with their patients

(Continued)

Table 1. (Continued).

Reference number	First Author, Published Year	Country	Data Collection Period	Vaccines Considered	Population	Sample Size (Response Rate)	Data Collection Method	Information Collected
[49]	Karnaki, 2019	14 EU countries	October 2012–April 2014	Influenza, tuberculosis, MMR, MenC, varicella, HAV, HBV, pneumonia, DTP	GPs and nurses	5,424 (NS)	Cross-sectional questionnaire	Demographics, specific vaccinations received over the last 10 years, reasons for not being immunized, attitudes and opinions toward obligatory vaccination
[50]	Raude, 2016	France	April–July 2014	Vaccinations in general and MMR, MenC, HPV, HBV, influenza	GPs	1,582 (92.4%)	Cross-sectional questionnaire	Demographics, frequency of recommendation, trust in sources of information, concerns about safety, beliefs about the importance/necessity of vaccines, confidence in their ability to explain the benefits and risks to patients, CAM practice, education related to vaccination
[51]	Lepiller, 2020	France	September 2018–May 2019	Vaccination in general	Medical students	530 (60.6%)	Cross-sectional questionnaire (before and after health promotion program)	Demographics, determinants of vaccine hesitancy, perceptions of vaccination, perceived preparedness to address vaccination concerns with patients
[52]	Karafilakis, 2016	4 European Union (EU) countries	NS	Vaccination in general	Physicians and nurses	65 (NS)	Semi-structured interviews	Vaccine hesitancy, perceptions of vaccine-related information, perceived role in responding to vaccine hesitancy
[53]	Harrison, 2016	Austria	March 2014	Recommended vaccines for health-care workers [§]	Nurses	116 (58%)	Cross-sectional questionnaire	Demographics, vaccination status, reasons for and against vaccination, sources of information, knowledge, risk perception
[54]	Baldoli, 2020	France	March–April 2019	Mandatory and recommended vaccines*	Medical students	542 (11.9%)	Cross-sectional questionnaire	Demographics, vaccination coverage, vaccine hesitancy, benefit/risk balance, safety and efficacy of vaccines, opinions on recommended and mandatory vaccines in HCPs
[55]	Wilson, 2020	France	November 2016–April 2017	Vaccination in general	GPs	19 (NS)	Semi-structured interviews	Attitudes on benefits and risks of vaccines, patient recommendations, interactions with hesitant patients, trust in sources of information and authorities
[56]	Kunze, 2020	Austria	March 2015	HAV, HBV, MMR, varicella, pertussis, influenza	Medical students	1,184 (17.61%)	Cross-sectional questionnaire	Demographics, general opinions about vaccinations, attitudes toward mandatory vaccinations, vaccination status
[57]	Agrinier, 2017	France	December 2013–March 2014	HPV, MMR, HBV, MenC	GPs	1,712 (46%)	Cross-sectional questionnaire	Demographics, HCPs' vaccination of their children, patient recommendations

(Continued)

Table 1. (Continued).

Reference number	First Author, Published Year	Country	Data Collection Period	Vaccines Considered	Population	Sample Size (Response Rate)	Data Collection Method	Information Collected
[58]	Deml, 2019	Switzerland	August 2017–November 2018	Childhood vaccinations and HPV	CAM practitioners	17 (NS)	Semi-structured interviews and observations during consultations	Demographics, previous training/education, interactions during consultation, perspectives on vaccination and immunity, perspectives on medicine and public health
[59]	Dybsand, 2019	United States of America (USA)	March 2017	Vaccination in general	Medical, pharmacy & nursing students	223 (23.7%)	Cross-sectional questionnaire	Basic vaccine knowledge, vaccine hesitancy, patient recommendations, attitudes, confidence in addressing vaccination with patients, appraisal of the education received on vaccination
[60]	Manca, 2018	Canada	2013–2014 (and one interview in April 2015)	Measles, pertussis, influenza	Physicians and nurses	34 (NS)	Semi-structured interviews	HCPs' narratives, experiences, and vaccine anxieties
[61]	Bonville, 2017	USA	NS	Childhood vaccines, HPV, influenza, DTP, varicella	Physicians	226 (41.5%)	Cross-sectional questionnaire	Vaccine beliefs, barriers, and immunization practices
[62]	Suryadevara, 2015	USA	June–November 2013	Childhood vaccinations, HPV, influenza	Pediatricians and nurses	680 (75.3%)	Cross-sectional questionnaire	Vaccine safety and effectiveness, patient recommendations, beliefs about side effects, self-reported vaccine hesitancy, sources of information, confidence in educating hesitant patients
[63]	MacDougall, 2015	Canada	NS	Influenza, pertussis, pneumonia, varicella	Nurses, GPs, pharmacists	1,167 (NS)	Cross-sectional questionnaire and focus group discussions	Attitudes towards vaccination recommendations, perceived role, benefits and risks of vaccination
[64]	Krishnaswamy, 2019	Australia	September–November 2016	Maternal vaccinations	GPs, midwives, obstetricians	870 (367/25% for obstetricians, 45/10% for obstetric trainees, 328/12% for GPs, 130/3% for midwives)	Cross-sectional questionnaire	Knowledge, perceived role in discussing and administering vaccines, current practices, and perceived barriers
[65]	Lee, 2018	New Zealand	2013–2014	Childhood vaccinations	GPs, pharmacists, midwives, dentists, CAM practitioners, & physiotherapists	1,032 (NS)	Cross-sectional questionnaire	Demographics, vaccine confidence
[66]	Eizayaga, 2015	Spanish & Portuguese-language countries	March–June 2015	Vaccination in general	CAM practitioners	512 (77.5% in Latin America, 16.8% in Spain)	Cross-sectional questionnaire	Vaccine hesitancy, attitudes towards vaccination (general beliefs on benefits, efficacy, safety; patient recommendations; opinions about mandatory vaccination)

MMR = measles, mumps, rubella; HBV = Hepatitis B Virus; MenC = meningitis C; HPV = Human Papillomavirus; GPs = General Practitioners; HCP = Health Care Professional; DTP = Diphtheria, Tetanus, Pertussis; HAV = Hepatitis A Virus; H1N1 = Hemagglutinin Type 1 and Neuraminidase Type 1 (also known as swine flu); NS = Not Specified

* Mandatory: DTP; Recommended: pertussis, HBV, measles, MMR, MenC, HPV, and varicella

[§]DTP, polio, HAV, HBV, influenza, varicella, MMR & pneumococcal and meningococcal vaccines

[‡]Mandatory: BCG, DTP, HBV; Recommended: influenza, pertussis, varicella, and MMR

Table 2. Dimensions used to measure VH and reported prevalence.

Reference number	First Author, Published Year, Country	Dimensions used to measure VH	VH prevalence
[29]	Verger et al, 2016, France	Classification of vaccine-related attitudes and behaviors	11% moderately VH 3% highly VH
[41]	Tomljenovic et al, 2021, Croatia	25 questions to generate score between 25–125	17% (score ≤ 81)
[48]	Wilson et al, 2020, France	Responding “yes” to declining a vaccine considered dangerous or unnecessary, delaying a vaccine because of doubts, or accepting a vaccine despite doubts about its efficacy or safety	44% VH
[50]	Raude et al, 2016, France	Recommendation frequency, trust in sources of information, safety, necessity of vaccines (proxy for complacency), confidence in explaining benefits/risks (proxy for self-efficacy)	-
[51]	Lepiller et al, 2020, France	Contextual, individual and group influences	-
[54]	Baldolli et al, 2020, France	Score of 0–10 (0 = no hesitancy, 10 = maximal hesitancy)	20% (score ≥ 3)
[59]	Dybsand et al, 2019, USA	Safety, benefit/risk perception, efficacy, and recommendation for child vaccination	-
[61]	Bonville et al, 2017, USA	-	3%

One of these articles involved a questionnaire given before and after the completion of a national public health promotion/prevention program, which included vaccination-related information [51].

Fewer studies (6/39, 15.4%) used qualitative methods to analyze data collected from semi-structured interviews or focus groups of HCPs [36,52,55,58,60,63]; and one study [63] used a mixed-methods approach from both surveys and focus groups to conduct a descriptive analysis. Wilson’s qualitative study [55] delved more deeply into the findings of a quantitative study [28].

3.2. Theoretical models and frameworks

Overall, 27/39 (69.2%) studies did not directly refer to existing theoretical models or frameworks as the basis for the measurement tools they used to collect data. One of these provided no details about their questionnaire’s development [35], and another specifically stated that their questionnaire was not based on any previously validated tool [33]. Most (25/39, 64.1%) cited literature reviews and previous qualitative interviews and/or focus groups with experts as the sources for the creation and validation of their data collection tools, but gave no detailed information about their theoretical frameworks or models [28,29,31,32,34,36,37,39–42,46,52,53,55–62,64–66].

Of the articles referencing previously used or validated theoretical models (12/39, 31.1%), two [38,45], both in Italian cohorts, based their questionnaires on the toolkit from the *Promotion of Immunization for Health Professionals in Europe* (H-ProlImmune) project [67], which was constructed from a systematic review; however, they did not use the exact questionnaire constructed in this project. Another study, implemented in 14 EU countries and identified as a participant in the H-ProlImmune project, used their validated framework to measure immunization attitudes and barriers [49]. Two studies were inspired by questionnaires proposed by the World WHO Strategic Advisory Group of Experts (SAGE) on Immunization designed to assess VH determinants [51,54]. Lepiller et al. (2020) explicitly referred to the three domains of drivers of hesitancy specified by the WHO SAGE group: ‘contextual influences,’ ‘individual and group influences,’ and ‘vaccine- or vaccination-specific issues’ [51]. An additional study

also incorporated nurses’ self-reported VH according to the WHO definition: ‘declining a vaccine considered dangerous or unnecessary; delaying a vaccine because of doubts about it, accepting a vaccine despite doubts about its efficacy or safety’ [48].

The short form (5-item) 5C-scale, developed by Betsch et al. (2018) to assess psychological antecedents of VH [68], was used in two articles to assess the determinants of vaccination behaviors among GPs, along with other measurements related to perception, knowledge, personal experience, and frequency of vaccine recommendations to patients [43,44]. One article incorporated the 3Cs model for determinants of VH from the WHO SAGE, in addition to 27 other questions related to socio-demographic characteristics, vaccination attitudes, and behavior [30]. Two articles adapted their questionnaires based on two separate existing theoretical frameworks, the ‘Theoretical Domains Framework’ and the ‘Awareness Adherence Model’ [50,63]. The questionnaires based on these existing frameworks were adapted according to independent study objectives, and their content validity was verified by expert panels. Finally, one article referred to the ‘Health Belief Model’ as the basis for their questions related to perceptions of vaccinations (i.e. perceived severity, susceptibility, benefits, costs, and cues to action) [47].

3.3. Measurement of VH and its proxies

Few quantitative studies (8/33, 24.2%) explicitly measured VH (Table 2) [29,41,50,51,54,55,59,61]; 5 of them estimated VH prevalence among HCPs from 3% to 44%. The other three studies did not present VH prevalence in their populations, but rather constructed VH scores and analyzed determinants related to these scores. Most studies (23/33, 69.7%) used one or more proxies to measure VH. These included HCPs’ vaccination status (8/23, 34.8%) [33,38,40,43,45,47,53,56], negative attitude toward/perception of vaccination (7/23, 30.4%) [35,37,39,42,45,49,66], the frequency of their vaccine recommendations to patients (6/23, 26.1%) [28,34,40,42,57,62], their children’s vaccination status (2/23, 8.7%) [34,57], acceptance of vaccine mandates for health-care workers [56] and for children [44] (2/23, 8.7%), and their delay/refusal of vaccination for themselves [30] or their children [31,46] (3/23, 13%). Two

remaining quantitative studies (2/33, 6.1%) did not specifically address or measure VH, but described individual determinants or aspects of VH such as confidence in vaccine knowledge [64] and perceived risks of specific diseases and their vaccines [32].

3.3.1. Self-vaccination as a proxy for VH

HCP self-vaccination behaviors, extended to include vaccination of their children [31,37,46,57], were mentioned in several articles and used as proxies for VH [30–33,37–41,43,45–49,53,54,56,57]. When self-vaccination status served as a proxy for VH [33,40,43,45,47,53,56], higher education level [33,56], sufficient knowledge [40,47,53], desire for self-protection [53], collective responsibility [43,47,53], and vaccine confidence [43] were found to be associated with higher vaccine uptake among HCPs. Other studies assessed the correlation between self-vaccination rates and VH: in a study in France, GPs with moderate-to-high VH had lower self-vaccination rates than those with no-to-slight VH [29], a correlation also seen in other studies [40–42,45,48,54,61,64]. One study, conducted in 14 EU countries, identified enablers of self-vaccination in HCPs as belief in vaccine protection and access to free-of-charge vaccines in the workplace, while barriers included varying concerns of different vaccines' short- and long-term effects [49]. Other studies simply reported vaccine coverage rates for different recommended vaccines (Table 3).

A study in Finland reported that 81.6% of HCPs (doctors and nurses) never hesitated, postponed, or rejected a vaccination for their own child [31]. In a Spanish study, 67.9% of nurses intended to vaccinate their children with

recommended vaccines, but 32.1% were hesitant [46]. Discrepancies existed between recommendations to patients and self-vaccination, with 98.6% of HCPs in one Italian study recommending the seasonal influenza vaccine to patients and 84.9% recommending the pneumococcal vaccine, while only 60.3% and 65.6% respectively were themselves vaccinated against these diseases [40]. Likewise, two separate studies in France found discrepancies between HCPs' children's vaccinations and these professionals' recommendations to patients [34,57]. Agrinier et al. (2017) found that 60% of GPs reported vaccinating their children but did not always recommend the same vaccines to their patients [57], while another found that 45.7% of GPs recommended certain vaccines to patients but had differing practices with their own children [34].

3.3.2. Vaccine recommendation to patients as a proxy for VH

Several articles either included HCP vaccine recommendation behaviors as an outcome of VH or as a proxy for measuring it [28,29,31,35,37,40–43,45,47,50,53,54,56,57,59,62,66]. Among the five articles using this behavior as a proxy for VH [28,40,42,57,62], the proportion of HCPs who never or sometimes recommended specific vaccines to targeted patients was 16% and 43%, respectively, in one study (France) [28], while only 5% in another declared they would not recommend certain vaccines to children (USA) [62]. One study found regional differences in terms of frequency of vaccine recommendations in France, attributing lower recommendation frequency scores to greater doubts about vaccine utility and risks and lower trust in information sources [42]. In other studies, HCPs

Table 3. Proportions of HCPs vaccinated across studies.

Vaccine	Article [Ref]	Proportion covered (%)	Proportion by HCP group	
			Physicians/GPs/Other [§]	Nurses/Other*
Influenza	Karlsson, 2019 [31], Finland	86.2 ¹	94.7	69.4*
	La Torre, 2017 [32], Italy	28.5	–	–
	Stefanoff, 2020 [37], Poland	62 ²	–	–
	Di Martino, 2020 [38], Italy	37.5 ³	58.2	20.7/11.5*
	Massot, 2018 [39], France	16.6 ²	32.6	16.3
	Tomljenovic, 2021 [41], Croatia	23.5 ²	–	–
	Karnaki, 2019 [49], Europe ⁴	56.2 ⁵	37.9 [§]	22.6*
	Wilson, 2020 [48], France	27 ¹	–	–
Diphtheritis-tetanus-pertussis (DTP)	Di Martino, 2020 [38], Italy	42.7 ³	36.1	30.7/38.5*
	Massot, 2018 [39], France	89.3	–	–
	Baldolli, 2020 [54], France	93.5	95.4	94.2
	Wilson, 2020 [48], France	57.5	52.5 [§]	59.3*
Hepatitis B	La Torre, 2017 [32], Italy	82	–	–
	Baldolli, 2020 [54], France	88.2	96.5	95.3
	Wilson, 2020 [48], France	61 ⁶	49.1 [§]	65.8*
Varicella	La Torre, 2017 [32], Italy	40	–	–
	Wilson, 2020 [48], France	39	50.8 [§]	36.5*
Measles-mumps-rubella (MMR)	La Torre, 2017 [32], Italy	40	–	–
	Wilson, 2020 [48], France	39	50.8 [§]	36.5*
	Di Martino, 2020 [38], Italy	49.9 ³	45.1	43.3/76.9*
	Baldolli, 2020 [54], France	94.8	95.8	94.2
	Wilson, 2020 [48], France	64	60.5 [§]	64.6*

[§]Other = Community nurses (Wilson, 2020).

*Other = Practical nurses (Karlsson, 2019), midwives (Di Martino, 2020), hospital nurses (Wilson, 2020).

¹Received influenza vaccine in the previous season.

²Reported taking influenza vaccine every year.

³Did not report missing vaccination.

⁴14 EU countries.

⁵Reported receiving at least one influenza vaccine in the last 10 years.

⁶At least three doses of the vaccine.

reported that they either did not recommend vaccines under any circumstances (12.5%, in Spanish & Portuguese-language countries) [66], did not follow recommendations of the childhood immunization program (7.8%, Poland) [37], or did not systematically recommend all vaccines (19.4%, France) [54].

3.4. Factors related to VH and its proxies

3.4.1. Professional and sociodemographic characteristics

Several professional and sociodemographic factors were identified as associated with VH or its proxies. Type of profession or health education program was highly correlated with VH in several studies [31,41,48,51,54,59,65]; VH was higher among nurses [31,41] than physicians in Finland and Croatia and higher among hospital nurses than community nurses in France [48]. A European study of medical students showed that trust in vaccines increased with the number of years of study [33]. Six studies also identified correlations between HCP type and VH proxies [31,35,38,39,45,54]. Vaccination coverage also differed by profession. For example, in Southern Italy, Di Martino et al. (2020) reported that, with physicians as the reference group, midwives were more likely to be vaccinated against measles, mumps, and rubella (MMR) (odds ratio [OR] 2.8; 95% confidence interval [CI] 1.1–7.6; $P = 0.047$) [38]. All other HCPs were associated with less frequent influenza vaccination than physicians in their study. Another Italian survey showed that nurse coordinators (57%) were more likely to be vaccinated against influenza than nurses (17%) ($P < 0.001$) [45]. This study found no difference in vaccine recommendations to patients between nurses and coordinating nurses however [45]. Although hospital nurses were identified as more hesitant than community nurses in France, vaccine coverage was higher in hospital nurses, likely due to more stringent monitoring and easier access to hospital vaccination services [48]. One study in New Zealand demonstrated that GPs, pharmacists, and dentists had more confidence in vaccines than midwives and CAM practitioners [65]. In Finland, Karlsson et al. (2019) showed that doctors had the highest levels of confidence in the benefits and safety of vaccines, compared with the different types of nurses surveyed, and that among nurses, confidence increased with level of education [31]. Differences in the degree of VH between HCPs can also be explained by the extent of their involvement in vaccination of the population.

A study in 34 EU countries [33] found that male medical students and junior doctors had higher influenza vaccine uptake than their female counterparts; women medical students were also more reluctant about the HPV vaccine than men [33].

A French study observed an association between older age and discrepancies between GPs' immunization practices for their children and their recommendations to patients, that is, they recommended certain vaccines for their patients with which they did not immunize their own children [34]. Finally, one study found lower VH in HCPs with versus without children [31].

3.4.2. Benefit/risk perceptions

Fear and history of vaccine-related adverse events/side-effects [29,30,41,51] were correlated with VH. They were also associated with VH proxies such as less confidence in vaccines (Czech Republic) [35], lower likelihood of vaccine recommendation to patients [28] (France), and lower vaccine uptake in HCPs (Great Britain and Austria) [47,53]. Vaccine recommendation as a proxy for VH was also associated with concerns over safety, with French and Italian GPs less likely to recommend a vaccine if they had doubts about its safety [40,42]. A study in Finland found that confidence in the benefits and safety of vaccines was associated with lower hesitancy for their own child's vaccination and that this confidence was highest among doctors [31]. Studies in Poland and Spain showed that a perception of the disease severity as low was associated with lower vaccination rates of HCPs' children [37,46].

3.4.3. Lack of trust in institutions, experts, and the pharmaceutical industry

Lack of trust in medical/pharmaceutical institutions/experts was also associated with VH and its various proxies in several studies [28,30,31,40,42,48,50,53,54,64]. In France, Raude et al. (2016) found that distrust in institutions was higher in older medical practitioners; however, concerns about vaccine safety and complacency completely mediated the effect of distrust in institutions on vaccine recommendations in their study, that is, these attitudes fully explained the relation between the lack of trust in institutions and the behavior of less frequent vaccine recommendation [50]. Baldolli et al. (2020) found that VH was lower among the nurses with the most trust in the French Ministry of Health [54].

3.4.4. Complementary and alternative medical practices

Several articles [29,30,34,35,41,43,65,66] mentioned the occasional practice of CAM and two in France found it was associated with direct measures of VH [29,30]. Several studies in Germany, New Zealand, and Spanish and Portuguese-language countries demonstrated lower recommendations of/confidence in vaccines among homeopathic doctors [43,65,66]. One study in France found that 71% of GPs practicing homeopathy ($P = 0.001$) and 81.8% ($P = 0.03$) acupuncture were more likely to have opinions and practices of immunization that differed for their patients compared with their own children than the rest of their panel of GPs (45.7%) [34]. Two studies nonetheless reported that homeopathy practices or support for 'healthy lifestyles and/or natural remedies' did not negatively affect HCPs' (medical students, physicians, and nurses) attitudes toward vaccination [35,41].

3.5. Attitudes toward vaccine mandates

One study examined whether HCPs' attitudes toward vaccine mandates were associated with determinants of VH measured by the 5C scale [44], and a second, whether these attitudes among medical students were associated with their self-reported vaccination status [56]. Several other studies used attitudes toward vaccination in general as proxies and also inquired about HCPs' attitudes and perceptions about

mandatory vaccination [32,33,48,49,53,54]. Most of these studies focused on attitudes toward mandatory vaccination for HCPs themselves [32,33,48,49,53,54,56], with some also inquiring about attitudes toward mandates for patients [44,54].

One study found that the mandatory status of the hepatitis B virus (HBV) vaccine, 3 doses, among nurses in France did not assuage nurses' fears about its safety and that study participants were hesitant about it, as measured by their continued doubt about its safety and efficacy [48]. Baldolli et al. (2020) found that disapproval of the French mandatory vaccination requirements in infants was a risk factor for low vaccination uptake among HCPs in their study. Nonetheless, they reported high vaccination rates (>85%) generally for all mandatory vaccines [54]. Kunze and Schweinzer in Austria found differences in mandate acceptance by the type of disease targeted; 83% of medical students favored compulsory vaccination for HBV, but only 40% for influenza [56]. A German study by Neufeind et al. (2021) found that physicians were more strongly in favor of vaccine mandates when they scored higher on vaccine confidence and collective responsibility, and lower on complacency. The pediatricians in their study were less in favor of vaccine mandates for children (61%) than other physician subgroups (71.8%), since pediatricians expected more negative consequences resulting from mandates in their daily practice than the other physicians [44].

Two studies found correlations between medical students' attitudes toward mandatory vaccination and vaccine-related behaviors [32,33]. The majority of those in an Italian study (77.8%) agreed that HBV vaccination should be mandatory for HCPs, and most of them (82%) were also vaccinated against HBV [32]. In the other study, however, in 34 EU countries, despite the high rate of self-reported support for mandatory vaccination against seasonal influenza and HBV (86%), 45.9% of the participants had never been vaccinated against seasonal influenza and as few as 18.1% reported the recommended annual vaccination [33]. The remaining studies mentioning HCPs' attitudes toward mandatory vaccination asked participants the question but provided no further analysis or interpretation of potential correlations between these attitudes and behaviors [49,53].

3.6. Qualitative studies

All six qualitative studies [36,52,55,58,60,63] included GPs in their interviews and/or focus groups; two also included nurses [60,63]. One study focused specifically on CAM practitioners and coupled interviewing them with observation of their consultations with patients [58]. While these qualitative studies did not specifically measure VH, they most notably supported findings from quantitative studies and described HCPs' perceptions of their role in vaccination recommendation [36,60,63], their VH-related concerns and their interactions with hesitant patients [52], their reasons for VH [55], and their vaccine-related experiences and behaviors [58,60,63].

Manca's work among physicians and nurses in Canada highlighted the lack of vaccination expertise of most HCPs, which can cause them to be uncertain or doubtful about its safety [60]. Although the HCPs interviewed accepted their role

in promoting vaccination, some expressed ambivalence about specific vaccines, including the influenza, HPV, rotavirus, shingles, and varicella vaccines. The participants' 'vaccine anxieties' were aligned with those of the public. Some also expressed skepticism about pharmaceutical research.

Most HCPs included in the mixed-methods study by MacDougall et al. (2015) in Canada noted that one of their duties is to discuss various aspects of vaccination with their patients and recommend vaccines to them. More than 90% considered it important to inform patients of vaccines' benefits [63]. GPs in this study nonetheless also expressed mistrust in health authorities, pharmaceutical companies, and national recommendations.

Another study of hesitant GPs took place in southern France [55] to elucidate the quantitative findings of Verger et al. (2015) that 25% of French GPs thought that some vaccines in the vaccine schedule were not useful [28]. The qualitative approach revealed that some GPs considered some vaccine-preventable diseases to be infrequent, citing the example of meningitis C. They thus felt that mass vaccination is not justified and preferred personalized vaccination based on individual children's characteristics and vulnerabilities. This study also showed that lack of trust in health authorities is an important driver of VH among GPs, partly due to hesitant GPs' perception of insufficient support from the authorities in their vaccination responsibilities. Other GPs expressed the reluctant trust they had to have in the health authorities and their advice to be able to do their work, despite their uncertainties about some vaccines or the vaccination strategy. Some participants suggested that vaccine recommendations, and in particular mandatory vaccination, conflicted with patient choice and could jeopardize the patient's trust in the GP.

GPs participating in a multicountry European study (Croatia, France, Greece, and Romania) voiced concerns over a lack of information regarding the safety of vaccines and the risks of receiving too many of them – information they needed to help their patients make decisions [52].

In Eilers' (2015) qualitative study, GPs in the Netherlands perceived prevention of disease as part of their role and viewed vaccination as an effective means of disease prevention, particularly for older patients. However, they also questioned the effectiveness, in particular, of the influenza vaccine [36]. This finding highlights potential correlations between HCPs' attitudes and behaviors with quantitative studies reporting lower vaccination coverage among HCPs specifically for the influenza virus [32,37–39,41,48,49]. Some GPs in Eilers's study did not concur with the idea of vaccinating older adults against diseases other than influenza and tetanus. They opposed the pneumococcal vaccination, feeling that experiencing disease is part of life and seeing pneumonia as an 'old man's best friend,' a 'kind way to depart.'

Lastly, Deml et al. (2019) studied doctors in Switzerland who practiced or supported CAM [58]. These providers reported nuanced positions on vaccination, with most describing favorable or ambivalent vaccine attitudes and regularly recommending vaccination to their patients. They emphasized individualized approaches to vaccination strategies for their patients, by discussing each item of the official Swiss vaccination schedule 'on a vaccine-by-vaccine, case-by-case basis.'

They expressed uncertainty about the possibility of long-term side effects on children's immune systems, especially the risk of autoimmune diseases, and about the induction of effects by aluminum on the organism, in particular the brain. Although official guidelines recommend the first vaccination at 2 months of age, providers reported delaying vaccines, often until 6 months of age, or older, or not recommending certain vaccines (for example, the MMR, poliomyelitis, HBV, or HPV vaccines). As Wilson et al. (2020) reported, CAM practitioners formulated their views based on their personal clinical experiences and their patients' vaccination experiences and expressed opinions that deviated from the generally accepted biomedical consensus on health and disease [55]. Finally, CAM practitioners highlighted the importance of respect, empathy, and patient involvement in vaccination decisions.

4. Discussion

4.1. Limitations

4.1.1. Limitation of this narrative review

Results of this review should be interpreted in the light of some limitations. We did not include Eastern, most Southern, or developing/emerging countries. The nature of VH, its prevalence, and determinants in these settings may differ substantially from those in Western countries. For example, the nature of convenience could be very different and its weight much more important in the Global South. Moreover, because multiple literature reviews have explored HCPs' attitudes toward specific vaccines, we assessed VH in general among HCPs, taking a variety of vaccines into account. This is consistent with the WHO's definition of VH, which encompasses different vaccines, and with HCPs' role in vaccinating patients, which is generally not restricted to a single vaccine. Finally, the quality of the studies was not appraised with a standardized tool, but we did systematically identify each study's methodological strengths and weaknesses.

4.1.2. Methodological issues in the studies

The heterogeneity of the methodological approaches used to measure VH in the quantitative studies reviewed here impedes the comparison of their findings. Furthermore, few studies were based on either validated tools or theoretical foundations. Even fewer assessed VH prevalence among HCPs: more often, VH was approximated by proxy indicators and was not based on either the WHO definition of VH or its three broad dimensions (3Cs). Proxy indicators were often exclusively behavioral indicators, such as self-vaccination or vaccine recommendations to patients. Nonetheless, these recommendations, while they could be influenced by HCPs' VH, might also depend on other factors not strictly related to VH, including vaccine availability, cost, and lack of information about the patients' vaccination status.

Some studies adopted a multidimensional approach to the measurement of HCPs' VH (based on both attitudes and behaviors) [29]; this brought them closer to the WHO definition and allowed a more pragmatic approach to prevalence estimates. This type of approach is limited by its extreme generality as survey respondents can take any past or present vaccine into

account. It is probably also subject to reporting bias. Other approaches were based on scores, which had the advantage of enabling degrees of VH to be measured (by the score level) [69].

More and more studies of HCPs use online questionnaires (33/39) because this approach to data collection is easier and less costly than other methods. But the low response rate to web questionnaire surveys among HCPs raises questions about their representativeness. Only 7/39 (18%) studies used strategies to limit selection bias [70] by sending reminders to potential participants [30,33,38,40,42,52,54], and 9/39 (23.1%) analyzed weighted data to adjust for various HCP characteristics (e.g. age, gender, profession) [28,29,42,43,48–50,57,65].

The heterogeneity observed in the analysis strategies also makes it difficult to quantify the relative weight of the different determinants of HCPs' VH, although this is essential in defining an intervention. Nonetheless, some methods, such as model-averaging, allow an estimation of the relative weight of the VH-associated factors [71].

We have noted the scarcity of mixed-methods research combining qualitative and quantitative studies. This type of approach could be very useful for a more detailed understanding of the conditions, mechanisms, and associations of factors that can lead HCPs to VH. The WHO has published a list of resources and tools for conducting quantitative and qualitative studies to assess VH among HCPs [72].

4.2. Discussion of the results

4.2.1. HCPs may share concerns similar to those of laypeople about vaccines

Beyond the wide variation of VH in HCPs by country, context, and setting [49], the central issue raised by Manca (2018) remains: HCPs are not experts in immunization in the same way as experts in this field. She underlined that HCPs are likely to have uncertainties or even doubts about the potential risks of vaccines, and that 'HCPs' anxieties aligned with public anxieties'. The results of this narrative review suggest that HCPs' attitudes about vaccines may be sensitive to public controversies and media coverage as well as to interactions with hesitant patients [28,34,52,53,57]. They may share the public's concerns about the side effects of some vaccines (e.g. seasonal flu, HBV, or HPV).

Our review also points out that complacency among HCPs is far from unusual [28,29,48,58]. Probably because vaccines are victims of their own success [73], some HCPs do not encounter some vaccine-preventable diseases and thus consider them rare and inappropriate to address by mass vaccination. As previously reported [74], they prefer individualized case-by-case approaches [48,58]. HCPs' complacency might also be underpinned by ethical or philosophical beliefs related to their perception of the limits of prevention and medicine among people with a low life expectancy [36]. Such attitudes are probably in a minority, in view of the recent broad adhesion of HCPs to priority COVID-19 vaccination of the elderly because of the disease's epidemiological and public health burden in this group.

The convergent results of our narrative review indicate that HCPs' VH (however measured) is strongly associated with a lack of knowledge about vaccines and, correlatively, with

the relevant curriculum during their training – its length and its vaccination-related content. Previous studies observed the same association for HCPs' self-vaccination against specific diseases, such as seasonal and pandemic A/H1N1 influenza and COVID-19 [19,20,26,75,76]. Consequently, HCPs' statements regarding the safety and efficacy of some vaccines may reflect perceptions or beliefs rather than strictly medical knowledge [20,76]. Some results further suggest that these perceptions/beliefs are enduring and difficult to modify in some HCPs, especially nurses [48,77]. Finally, longer, more advanced medical training is associated with better self-confidence in discussing vaccine-related issues with patients, while a lack of self-confidence may explain hesitant HCPs' lesser commitment to addressing their patients' VH [31,55,59,78]. All of these results suggest that a social gradient of VH, more or less similar to that among the general population, also occurs among HCPs [79], although their professional experience with vaccination, relationships with their peers, and the type of patients they see also shape their vaccine confidence [38]. The contribution of perceived constraints to VH among HCPs has been little studied and seems mainly to influence their own vaccination behaviors [43].

4.2.2. An important determinant of HCPs' VH: trust in health authorities, the pharmaceutical industry, and experts

Lack of trust in institutions is a central determinant of VH [80]. This is why the role of HCPs is essential in the field of immunization: many patients trust their HCPs enough to delegate their health care decisions to them [14]. Giddens (a sociologist) has theorized that true trust can be built only in a close face-to-face relationship [81]. HCPs, especially family doctors, therefore constitute a rampart in the health field against the population's distrust of authorities, the pharmaceutical industry, and even experts – all remote actors. This distrust exists in many countries, but its intensity depends on the sociopolitical and cultural context [82]. Our findings in this narrative reviews indicate that this also applies to HCPs themselves: those who distrust institutions are more likely to be vaccine-hesitant and less likely to recommend vaccines to patients [28,50,52,53,55,60,63]. Lack of trust in authorities may be explained by multiple factors including HCPs' perceptions [55] of a lack of support for their public health vaccination duties by health authorities; of the latter's (poor) management of health crises (past or present) [18,83]; of conflicts of interest between health authorities and the pharmaceutical industry, and of lack of transparency about vaccine side effects [52,55,60]. The mistrust by hospital staff of authorities may be related to their perceptions that their working conditions are deteriorating [84]. Mistrust by some HCPs, especially those also providing CAM, may also be linked to their critical views of the established health systems and guideline development [58].

4.2.3. A specific aspect of trust in vaccination: reluctant trust

The results of this narrative review suggest that most HCPs generally trust vaccination and accept their role in it. They can however face uncertainties and unknowns in dealing with vaccination in concrete situations that can complexify their decisions and recommendations. In this context, as shown by

a qualitative study included in this review and a previous study of HCPs' attitudes about the MMR and autism controversy [55,85], HCPs may have no choice but to take the 'leap of faith' that Giddens described for laypeople relying on technologies, to trust vaccines, however reluctantly [81,85]. Reluctant trust is important to assess in various contexts and types of HCPs as it might be a barrier to their full engagement in immunization. Keeping up-to-date on vaccines in medical practice today is an important challenge, especially during a health crisis with constantly evolving information, so that sometimes even the best informed HCP must rely on a leap of faith (reluctant trust) [86].

4.2.4. HCPs' VH and interactions with patients and CAM HCPs

Because the interaction between patients and providers is key in addressing patient concerns about vaccines [10,11], it is essential to understand how and to what extent HCPs' VH affects their attitudes and behaviors during this interaction. This narrative review suggests that the patient-HCP relationship might be affected when HCPs are hesitant, for they might be less likely to have conversations with patients about vaccination [31,55] and feel less comfortable providing explanations about some alleged side effects [28]. VH in HCPs may thus weaken their perceived self-efficacy and their commitment to their work regarding vaccination [78].

Most studies addressing VH in CAM HCPs (or health students) found that they have a higher level of hesitancy [29,30,43,58] and present different attitudes toward patients compared with non-CAM practitioners. CAM physicians are more likely to show openness to their patients' views in addressing vaccination than their non-CAM colleagues do [58]. As Deml et al. (2019) argue, engaging patients can activate their agency in vaccination decisions and help them address their VH. Openness to patients is especially relevant because it is central in motivational interviewing, an approach based on empathy, listening to patients, and respecting their autonomy [87]. Motivational interviewing builds on these attitudes to create a bond of trust between the patient and the HCP to set the patient on the path to behavioral change, in this context, vaccine acceptance. Hesitant or CAM HCPs (or students) had a different perspective, however: their focus on individual patient choice rather than on any public health dimension which makes them less inclined to motivate patients to accept vaccination [48,63,78]. Moreover, openness to the patient among hesitant HCPs could explain why they may be more influenced by patients' negative experiences with vaccines (real or alleged) than other HCPs [52,78].

4.2.5. HCPs' VH and their opinions on mandates

The question of the use of mandates to ensure high vaccine coverage in the general population but also in HCPs is old [88] and still controversial. The COVID-19 health crisis and the imposition of mandatory vaccinations for HCPs in several Western countries (e.g. the USA, UK, France, and Austria) has reactivated this debate. Because HCPs are vectors of opinion toward their patients, knowledge of their views on population-based mandates is important. This type of public health policy works best when HCPs agree with it. Since HCPs' views on this

topic have been reviewed [89,90], we discuss only some of the points raised here. Although some studies indicate high HCP adherence to population mandates, other HCPs, especially those who are vaccine-hesitant, show less support for mandatory policies. One study in particular [44] points out the risks pediatricians perceive in these measures. One is reactance (i.e. resistance to an instruction perceived as impairing freedom of choice), which was shown to be high during COVID-19 vaccination campaigns [91–93]. Moreover, mandatory measures for HCPs, as for the public, do not necessarily improve vaccine confidence [48].

4.3. Implications for practice

4.3.1. Review vaccination in all HCP training programs

Studies show that HCPs' initial training in immunization does not prepare them adequately for clinical practice [32,33,51,59,60,94–97]. It is thus essential to assess and improve, in a manner tailored to each context and setting, the importance and content of immunization courses in each HCP's initial training program. First, improving health students' scientific knowledge about vaccination – its principles, the technologies used to manufacture vaccines, and the clinical phases of vaccine development, along with vaccine policies and pharmacovigilance (drug safety monitoring) – is a priority. In particular, better preparing HCPs to explain new vaccine technologies to their patients is a critical issue, given the difficulties faced by health authorities and scientists during the COVID-19 pandemic in educating the public about the new vaccines for this disease. Second, these programs should ensure the acquisition of skills to decipher false information and address patient VH without eliciting resistance. Guidelines are necessary to define these skills, as various approaches and counseling strategies for communicating with patients about vaccination have been proposed [98]. For example, enough evidence about the effectiveness of motivational interviews has accumulated to generalize its use in Quebec maternity wards (EMMIE program) [99]. In addition to HCPs' initial training, continuous education on vaccines remains essential to provide up-to-date information about the newest generations of vaccine technology. Education about immunization should also be directed at certain target groups who may have a significant influence on people's attitudes – legislators, teachers, journalists, etc.

4.3.2. Facilitate HCPs' access to reliable information for use in consultations

Currently, information for HCPs is often dispersed, emanates from multiple sources, and is available from tools that most often are not designed to be used in a consultation setting, with its constraints of time and need for personalized approaches. Specific efforts in the field of COVID-19, for example, have led to the translation of the COVID-19 Vaccine Communication Handbook into 11 languages, enabling it to arm HCPs with practical tips and provide them with up-to-date information and evidence to talk comfortably and reliably about the vaccines [100]. Given the number of tools and sources, efforts should be made to identify and recommend

to HCPs those most useful for them, based, for example, on recommendations by panels of HCPs and health-care system users.

4.4. Implications for future research

Overall, future studies are needed to better understand the prevalence and determinants of vaccine hesitancy among different populations in Western countries and especially in non-Western countries, where data on these issues are particularly sparse. In particular, apart from the general population and HCPs, there is a lack of data on VH among medical and social service professionals.

4.4.1. Development and validation of instruments to measure VH and its determinants among HCPs

Developing and validating instruments solidly anchored in theoretical foundations to measure the prevalence of VH among different types of HCPs and study its determinants in different settings and countries is a research priority in the area of VH. In this perspective, we have developed and validated the Pro-VC-Be questionnaire (Health Professionals-Vaccine Confidence and Vaccination Behaviors) in French; its international validation is underway in different European countries within the framework of the H2020 'Jitsuvax' project [101]. It measures vaccine confidence, self-efficacy, commitment to vaccination, confidence in institutions, reluctant trust, openness to patients, and perceived constraints. A British group has also developed and validated a questionnaire to measure influenza vaccination acceptance in HCPs [102], and an international group centered in China and Taiwan has adapted it for the measurement of COVID-19 vaccination acceptance [103].

4.4.2. Better understanding of the dynamics of patient-provider interactions

Few articles have addressed HCP-patient interactions in the field of VH [58,104] by observing consultations. This is an essential research topic given the VH-associated behavioral, attitudinal, and communication issues in the patient-provider relationship [104]. It is also essential to understand how VH affects HCPs' attitudes toward patients and how susceptible they are to misinformation that their patients may provide.

4.4.3. Development of intervention research to reduce VH

Knowledge about the effectiveness of the various approaches for overcoming VH remain sparse [105]. Within the specific scope of this literature review, intervention research is needed to evaluate the impact and effectiveness of different approaches to: 1) addressing the hesitancy of various categories of HCPs, 2) enabling them to acquire the appropriate skills to address their patients' hesitancy, and 3) responding appropriately to the misinformation to which they and their patients are exposed. The Jitsuvax Project [101] will test interventions using refutation-based learning to enhance vaccine uptake and knowledge and reduce VH among HCPs and the public.

5. Conclusion

This narrative review highlighted the following main findings. First, VH, defined by the WHO 3Cs model as (lack of) confidence, complacency, and (lack of) convenience, indeed exists among HCPs, to degrees and frequencies that vary by country, region, setting, type of profession and practice, and sociodemographic characteristics. Second, most often, VH is generally more prevalent in HCPs with shorter medical educations, e.g. nurses versus physicians. Third, a general determinant of VH, including among HCPs, is a lack of trust in health authorities, the pharmaceutical industry, or even experts. This lack of trust can reveal HCPs' perception that the official vaccine strategy is unclear, or difficult to understand. Fourth, the consequences of VH are lower vaccine uptake among HCPs themselves, a lower likelihood they will recommend various vaccines to patients, and lower self-efficacy or commitment to guiding hesitant patients toward vaccination. Addressing VH among HCPs – by improved medical training and offering personalized counseling – is therefore a priority, together with improving or maintaining their trust in institutions and experts.

6. Expert opinion

The public health crisis linked to COVID-19 clearly shows (1) the importance of achieving high levels of vaccination coverage and maintaining them over time in all populations; (2) the important role of HCPs who can set an example by vaccinating themselves and who can effectively address the concerns of their patients; and (3) that policies based on health or vaccination passports can be very effective in achieving high levels of vaccine coverage, but frequently hit a ceiling, with a more or less important part of the population remaining unvaccinated. Reducing HCPs' VH and equipping them with the appropriate tools and skills to address their patients' concerns effectively are essential steps that could have a considerable impact on population-based vaccination levels. Although this will require significant intervention research efforts, the example of the EMMIE program in Quebec [99] indicates that this is realistic and cost-effective. Moreover, the Tailoring Immunization Programmes (TIP) approach developed by the WHO Regional Office for Europe provides useful support for the realistic translation of knowledge into improved practices.

Intervention research on VH is in its infancy: although the COVID crisis will likely have helped to boost it by sparking innovations, it will take time for the results to be applied. Convincing evidence of the effectiveness of some approaches to address VH exists (e.g. motivational interviewing), but the challenges now include issues of transferability to different socio-cultural contexts and the feasibility of scaling up these approaches. Solutions potentially exist through the diversification of training means (training of trainers, face-to-face training, virtual training) and the combination of different intervention levers to reach the greatest number of HCPs.

The potential of further research is important given that understanding and addressing VH in HCPs can benefit from the input of various disciplines (social, behavioral, political,

and education sciences, but also information technologies). A definitive endpoint seems rather unlikely, given the considerable developments observed over the last few decades in the patient-provider relationship, information technologies, connected health tools, and the emergence of social networks. The next few decades will in all likelihood be marked by major developments in the use of Big Data and behavioral prediction algorithms in preventive care, and efforts to preserve safe conditions of access to personal data.

Progress must be made to further improve access to vaccines for vulnerable populations, even in developed societies, in view of the social and digital fractures existing today. In addition, the fight against misinformation has become a major issue. In this regard, improving the education of children and adolescents in schools to raise awareness of these issues and equip them (e.g. myth prebunking and debunking) is a potentially promising area of research. Vaccine education of professional groups other than HCPs (legislators, teachers, health mediators, professional caregivers of vulnerable persons ...) is also an avenue to consider.

Developments in the field will largely depend on the awareness of governments and international institutions of the importance of funding research and efforts to transform knowledge into action in this field (reducing vaccine hesitancy). The risk is that of a widening of the gap between fundamental and technological research capable of producing ever more rapidly effective vaccines and their insufficient social acceptance, which would further undermine the impact of future vaccine campaigns. The temptation to resort to mandatory vaccination in several countries, at the time of this writing, raises serious questions. While mandates may be an effective way of achieving rapidly the high vaccination rates required to ensure collective protection and are, for this reason, measures that may seem appropriate in a crisis situation [88], they carry a twofold risk: 1) a loosening of educational efforts and associated research developments, when precisely the reverse is essential; 2) a social backlash by provoking reluctance [106], polarization, and even social violence as already seen in some countries. These risks could jeopardize the future, by further undermining the institutional trust of certain categories of the population.

Within five years, the prevalence of VH among HCPs will be better known and its determinants better understood, thanks to the increased use of validated tools and their adaptation in different languages (including in emerging and developing countries) [107]. The likely development of observation devices for consultations should allow a better understanding of the dynamics of patient-provider interactions and provide useful elements for the design of interventions targeting HCPs.

Intervention research efforts on how to reduce HCPs' VH and allow them to acquire the skills to address patients' VH should already have been successful in some countries. However, transferring the knowledge gained or translating it into the training curricula of HCPs will likely take longer (multiple competing priorities in HCP training, changing roles of health professions, especially nurses) with significant variation across countries.

In addition, the politicization of vaccination, the development of CAM practices, and the arrival of new vaccine platforms could maintain or reactivate vaccine hesitancy among HCPs. A substantial increase in educational efforts of the population and training of HCPs about vaccination and its new technologies is thus crucial without delay.

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Authors contributions

PV, DG, ED, EBN, AGB, and ArG defined the search strategy and the inclusion criteria for the articles. DG implemented the search strategy on the Medline and Embase databases. PV, DG, ED, EBN, and AGB read the abstracts, selected the articles to be included in the review, and described them in an Excel file. PV, AmG, DG, and ED wrote the paper and EBN, AGB, and ArG revised it critically for intellectual content. All authors approved it for publication and agree to be accountable for all aspects of the work.

ORCID

Pierre Verger  <http://orcid.org/0000-0002-0339-0679>

Elisabeth Botelho-Nevers  <http://orcid.org/0000-0003-2773-7750>

References

Papers of special note have been highlighted as either of interest (•) or of considerable interest (↔) to readers.

1. Ten health issues WHO will tackle this year [Internet]. cited 2021 Dec 8]: Available from 2021 Dec 8 <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>.
2. Larson HJ. The state of vaccine confidence. *Lancet*. 2018;392(10161):2244–2246.
3. Sallam M. COVID-19 vaccine hesitancy worldwide: a concise systematic review of vaccine acceptance rates. *Vaccines (Basel)*. 2021;9(2):160.
4. Lin C, Tu P, Beitsch LM. Confidence and receptivity for COVID-19 vaccines: a rapid systematic review. *Vaccines (Basel)*. 2020;9(1):16.
5. Shapiro GK, Kaufman J, Brewer NT, et al. A critical review of measures of childhood vaccine confidence. *Curr Opin Immunol*. 2021;71:34–45.
- Update of the definition of Vaccine Hesitancy by the WHO Behavioral and Social Drivers of Vaccinations working group.
6. Machingaizze S, Wiysonge CS. Understanding COVID-19 vaccine hesitancy. *Nat Med*. 2021;27(8):1338–1339.
7. Dror AA, Eisenbach N, Taiber S, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. *Eur J Epidemiol*. 2020;35(8):775–779.
8. Yaqub O, Castle-Clarke S, Sevdalis N, et al. Attitudes to vaccination: a critical review. *Soc Sci Med*. 2014;112:1–11.
9. Dubé E, Gagnon D, MacDonald N, et al., Underlying factors impacting vaccine hesitancy in high income countries: a review of qualitative studies. *Expert Rev Vaccines*. 17(11): 989–1004. 2018.
- A literature review of qualitative studies expanding on attitudes and behaviors towards vaccination, using a socio-ecological model as a conceptual framework.
10. Leask J, Kinnersley P, Jackson C, et al. Communicating with parents about vaccination: a framework for health professionals. *BMC Pediatr*. 2012;12(1):154.
11. Gagneur A. Motivational interviewing: a powerful tool to address vaccine hesitancy. *Canada Communicable Disease Report*. 2020;46(4):93–97.
12. Wheeler M, Buttenheim AM. Parental vaccine concerns, information source, and choice of alternative immunization schedules. *Hum Vaccines Immunother*. 2013;9(8):1782–1789.
13. Favin M, Steinglass R, Fields R, et al. Why children are not vaccinated: a review of the grey literature. *Int Health*. 2012;4(4):229–238.
14. Peretti-Watel P, Ward JK, Vergelys C, et al. "I think I Made the right decision ... I hope i'm not wrong." Vaccine hesitancy, commitment and trust among parents of young children. *Sociol Health Illn*. 2019;41(6):1192–1206.
15. Paterson P, Meurice F, Stanberry LR, et al., Vaccine hesitancy and healthcare providers. *Vaccine*. 34(52): 6700–6706. 2016.
- The first literature review on vaccine hesitancy among healthcare professionals.
16. Verger P, Dualé C, Lenzi N, et al. Vaccine hesitancy among hospital staff physicians: a cross-sectional survey in France in 2019. *Vaccine*. 2021;39(32):4481–4488.
17. Dzieciolowska S, Hamel D, Gadio S, et al. Covid-19 vaccine acceptance, hesitancy, and refusal among Canadian healthcare workers: a multicenter survey. *Am J Infect Control*. 2021;49(9):1152–1157.
18. Verger P, Scronias D, Dauby N, et al. Attitudes of healthcare workers towards COVID-19 vaccination: a survey in France and French-speaking parts of Belgium and Canada, 2020. *Euro Surveill*. 2021;26(3):2002047.
19. Gagneux-Brunon A, Detoc M, Bruel S, et al. Intention to get vaccinations against COVID-19 in French healthcare workers during the first pandemic wave: a cross-sectional survey. *J Hosp Infect*. 2021;108:168–173.
20. Brownlie J, Howson A. "Between the demands of truth and government": health practitioners, trust and immunisation work. *Soc Sci Med*. 2006;62(2):433–443.
- Qualitative study suggesting that providers' opinions and practices toward vaccines are influenced by determinants well beyond evidence and facts
21. Prematunge C, Corace K, McCarthy A, et al. Factors influencing pandemic influenza vaccination of healthcare workers—a systematic review. *Vaccine*. 2012;30(32):4733–4743.
22. Dini G, Toletone A, Sticchi L, et al. Influenza vaccination in healthcare workers: a comprehensive critical appraisal of the literature. *Hum Vaccin Immunother*. 2018;14(3):772–789.
23. Guillari A, Polito F, Pucciarelli G, et al. Influenza vaccination and healthcare workers: barriers and predisposing factors. *Acta Biomed*. 2021;92(S2):e2021004.
24. Rosen BL, Shepard A, Kahn JA. US Health Care Clinicians' knowledge, attitudes, and practices regarding Human papillomavirus

- vaccination: a qualitative systematic review. *Academic Pediatrics*. 2018;18(2):S53–S65.
25. Escriva-Boulley G, Mandrik O, Préau M, et al. Cognitions and behaviours of general practitioners in France regarding HPV vaccination: a theory-based systematic review. *Prev Med*. 2021;143:106323.
 26. Biswas N, Mustapha T, Khubchandani J, et al. The nature and extent of COVID-19 vaccination hesitancy in healthcare workers. *J Community Health*. 2021;46(6):1244–1251.
 27. MacDonald NE; SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: definition, scope and determinants. *Vaccine*. 2015;33(34):4161–4164.
 - **Work from the 2012-14 WHO SAGE to create a common definition to measure vaccine hesitancy.**
 28. Verger P, Fressard L, Collange F, et al., Vaccine hesitancy among general practitioners and its determinants during controversies: a national cross-sectional survey in France. *EBioMedicine*. 2(8): 891–897. 2015.
 - **The first study using a score to assess the prevalence of vaccine hesitancy (VH) among GPs. Findings of this study showed mistrust in authorities is a major contributor to VH in health-care providers.**
 29. Verger P, Collange F, Fressard L, et al. Prevalence and correlates of vaccine hesitancy among general practitioners: a cross-sectional telephone survey in France. *Euro Surveill*. 2014 [Apr Jul];21(47):30406.
 30. Thomire A, Raude J. The role of alternative and complementary medical practices in vaccine hesitancy among nurses: a cross-sectional survey in Brittany. *Infectious Diseases Now*. 2021;51(2):159–163.
 31. Karlsson LC, Lewandowsky S, Antfolk J, et al., The association between vaccination confidence, vaccination behavior, and willingness to recommend vaccines among Finnish healthcare workers. *PloS One*. 14(10): e0224330. 2019.
 - **Quantitative study suggesting a link between confidence and the degree of medical training.**
 32. La Torre G, Scalingi S, Garruto V, et al. Knowledge, attitude and behaviours towards recommended vaccinations among healthcare workers. *Healthcare (Basel)*. 2017;5(1):13.
 33. Rostkowska OM, Peters A, Montvidas J, et al. Attitudes and knowledge of European medical students and early graduates about vaccination and self-reported vaccination coverage-Multinational cross-sectional survey. *Int J Environ Res Public Health*. 2021;18(7):3595.
 34. Killian M, Detoc M, Berthelot P, et al. Vaccine hesitancy among general practitioners: evaluation and comparison of their immunisation practice for themselves, their patients and their children. *Eur J Clin Microbiol Infect Dis*. 2016;35(11):1837–1843.
 35. Šálek J, Čelko AM, Dáňová J. Vaccination perception and attitude among undergraduate medical and teacher education students at Charles University, Prague, Czech Republic. *Vaccines (Basel)*. 2020;8(1):136.
 36. Eilers R, Krabbe PFM, de Melker HE. Attitudes of Dutch general practitioners towards vaccinating the elderly: less is more? *BMC Fam Pract*. 2015;16(1):158.
 37. Stefanoff P, Sobierajski T, Bulinska-Stangrecka H, et al. Exploring factors improving support for vaccinations among Polish primary care physicians. *PLoS One*. 2020;15(5):e0232722.
 38. Di Martino G, Di Giovanni P, Di Girolamo A, et al. Knowledge and attitude towards vaccination among healthcare workers: a multicenter cross-sectional study in a Southern Italian Region. *Vaccines (Basel)*. 2020;8(2):248.
 39. Massot E, Epaulard O. Midwives' perceptions of vaccines and their role as vaccinators: the emergence of a new immunization corps. *Vaccine*. 2018;36(34):5204–5209.
 40. Vezzosi L, Riccò M, Agozzino E, et al. Knowledge, attitudes, and practices of general practitioners from the province of Parma (Northern Italy) towards vaccinations in adults ≥ 65 year-old. *Acta Biomed*. 2019;90(9–S):71–75.
 41. Tomljenovic M, Petrovic G, Antoljak N, et al. Vaccination attitudes, beliefs and behaviours among primary health care workers in northern Croatia. *Vaccine*. 2021;39(4):738–745.
 42. Collange F, Zaytseva A, Pulcini C, et al. Unexplained variations in general practitioners' perceptions and practices regarding vaccination in France. *Eur J Public Health*. 2019;29(1):2–8.
 43. Neufeind J, Betsch C, Habersaat KB, et al., Barriers and drivers to adult vaccination among family physicians – insights for tailoring the immunization program in Germany. *Vaccine*. 38(27): 4252–4262. 2020.
 - **Quantitative study using a validated tool to assess psychological antecedents of vaccination among GPs. Findings showed the role of collective responsibility, perceived constraints and complacency in GPs self-vaccination.**
 44. Neufeind J, Betsch C, Zylka-Menhorn V, et al. Determinants of physician attitudes towards the new selective measles vaccine mandate in Germany. *BMC Public Health*. 2021;21(1):566.
 45. Tamburrano A, Mellucci C, Galletti C, et al. Improving nursing staff attitudes toward vaccinations through academic detailing: the HProlImmune questionnaire as a tool for medical management. *Int J Environ Res Public Health*. 2019;16(11):E2006.
 46. Elizondo-Alzola U, Carrasco MG, Pinós L, et al. Vaccine hesitancy among paediatric nurses: prevalence and associated factors. *PLoS One*. 2021;16(5):e0251735.
 47. Little KE, Goodridge S, Lewis H, et al. Occupational vaccination of health care workers: uptake, attitudes and potential solutions. *Public Health*. 2015;129(6):755–762.
 48. Wilson RJL, Zaytseva A, Bocquier A, et al. Vaccine hesitancy and self-vaccination behaviors among nurses in Southeastern France. *Vaccine*. 2020;38(5):1144–1151.
 49. Karnaki P, Baka A, Petralias A, et al. Immunization related behaviour among healthcare workers in Europe: results of the HProlImmune survey. *Central European Journal of Public Health*. 2019;27(3):204–211.
 50. Raude J, Fressard L, Gautier A, et al. Opening the “Vaccine Hesitancy” black box: how trust in institutions affects French GPs' vaccination practices. *Expert Rev Vaccines*. 2016;15(7):937–948.
 51. Lepiller Q, Bouiller K, Slekovec C, et al. Perceptions of French healthcare students of vaccines and the impact of conducting an intervention in health promotion. *Vaccine*. 2020;38(43):6794–6799.
 52. Karafilakis E, Dinca I, Apfel F, et al. Vaccine hesitancy among healthcare workers in Europe: a qualitative study. *Vaccine*. 2016;34(41):5013–5020.
 53. Harrison N, Brand A, Forstner C, et al. Knowledge, risk perception and attitudes toward vaccination among Austrian health care workers: a cross-sectional study. *Hum Vaccin Immunother*. 2016;12(9):2459–2463.
 54. Baldoli A, Michon J, Verdon R, et al. Vaccination perception and coverage among healthcare students in France in 2019. *BMC Med Educ*. 2020;20(1):508.
 55. Wilson RJL, Vergélys C, Ward J, et al., Vaccine hesitancy among general practitioners in Southern France and their reluctant trust in the health authorities. *International Journal of Qualitative Studies on Health and Well-being*. 15(1): 1757336. 2020.
 - **Qualitative study that expands on reasons for VH among GPs in France and demonstrates reluctant trust that GPs have in health authorities, a relatively new concept in VH studies.**
 56. Kunze U, Schweinzer H. Self-reported vaccination status and attitudes towards mandatory vaccinations for health care workers among medical students. *Vaccine*. 2020;38(35):5695–5699.
 57. Agrinier N, Le Maréchal M, Fressard L, et al. Discrepancies between general practitioners' vaccination recommendations for their patients and practices for their children. *Clin Microbiol Infect*. 2017;23(5):311–317.
 58. Deml MJ, Notter J, Kliem P, et al. “We treat humans, not herds!”: a qualitative study of complementary and alternative medicine (CAM) providers' individualized approaches to vaccination in Switzerland. *Soc Sci Med*. 2019;240:112556.

- **Qualitative study of CAM practitioners that highlights the importance of respect, empathy, and patient involvement in vaccination decisions**
59. Dybsand LL, Hall KJ, Carson PJ. Immunization attitudes, opinions, and knowledge of healthcare professional students at two Midwestern universities in the United States. *BMC Med Educ*. 2019;19(1):242.
 60. Manca T. "One of the greatest medical success stories:" physicians and nurses' small stories about vaccine knowledge and anxieties. *Soc Sci Med*. 2018;196:182–189.
 61. Bonville CA, Domachowske JB, Cibula DA, et al. Immunization attitudes and practices among family medicine providers. *Hum Vaccin Immunother*. 2017;13(11):2646–2653.
 62. Suryadevara M, Handel A, Bonville CA, et al. Pediatric provider vaccine hesitancy: an under-recognized obstacle to immunizing children. *Vaccine*. 2015;33(48):6629–6634.
 63. MacDougall DM, Halperin BA, MacKinnon-Cameron D, et al. The challenge of vaccinating adults: attitudes and beliefs of the Canadian public and healthcare providers. *BMJ Open*. 2015;5(9):e009062.
 64. Krishnaswamy S, Wallace EM, Buttery J, et al. A study comparing the practice of Australian maternity care providers in relation to maternal immunisation. *Aust N Z J Obstet Gynaecol*. 2019;59(3):408–415.
 65. Lee C, Duck I, Sibley CG. Confidence in the safety of standard childhood vaccinations among New Zealand health professionals. *N Z Med J*. 2018;131(1474):60–68.
 66. Eizayaga JE, Waisse S. What do homeopathic doctors think of vaccines? An international online survey. *Homeopathy*. 2016;105(2):180–185.
 67. HProImmune [Internet]. cited 2021 Dec 10; Available from 2021 Dec 10 <http://www.hproimmune.eu/>.
 68. Betsch C, Schmid P, Heinemeier D, et al. Beyond confidence: development of a measure assessing the 5C psychological antecedents of vaccination. *PLoS One*. 2018;13(12):e0208601.
 69. Strategic Advisory Group of Experts on Immunization [Internet]. cited 2021 Dec 10; Available from 2021 Dec 10 [https://www.who.int/groups/strategic-advisory-group-of-experts-on-immunization/working-groups/cholera-\(november-2015—august-2017\)](https://www.who.int/groups/strategic-advisory-group-of-experts-on-immunization/working-groups/cholera-(november-2015—august-2017)).
 70. Verger P, Scronias D, Fradier Y, et al. Online study of health professionals about their vaccination attitudes and behavior in the COVID-19 era: addressing participation bias. *Hum Vaccin Immunother*. 2021;17(9):2934–2939.
 71. Turkheimer FE, Hinz R, Cunningham VJ. On the undecidability among kinetic models: from model selection to model averaging. *J Cereb Blood Flow Metab*. 2003;23(4):490–498.
 72. TIP Tailoring Immunization Programmes (2019) [Internet]. cited 2021 Dec 10; Available from 2021 Dec 10: <https://www.euro.who.int/en/health-topics/disease-prevention/vaccines-and-immunization/publications/2019/tip-tailoring-immunization-programmes-2019>.
 73. Larson HJ, Cooper LZ, Eskola J, et al. Addressing the vaccine confidence gap. *Lancet*. 2011;378(9790):526–535.
 74. McMurtry A, Wilson K, Clarkin C, et al. The development of vaccination perspectives among chiropractic, naturopathic and medical students: a case study of professional enculturation. *Advances in Health Sciences Education*. 2015;20(5):1291–1302.
 75. Bish A, Yardley L, Nicoll A, et al. Factors associated with uptake of vaccination against pandemic influenza: a systematic review. *Vaccine*. 2011;29(38):6472–6484.
 76. Ward JK, Peretti-Watel P, Bocquier A, et al. Vaccine hesitancy and coercion: all eyes on France. *Nat Immunol*. 2019;20(10):1257–1259.
 77. Rey D, Fressard L, Cortaredona S, et al. Vaccine hesitancy in the French population in 2016, and its association with vaccine uptake and perceived vaccine risk-benefit balance. *Euro Surveill*. 2018;23(17):17–00816.
 78. Bouchez M, Ward JK, Bocquier A, et al. Physicians' decision processes about the HPV vaccine: a qualitative study. *Vaccine*. 2021;39(3):521–528.
 79. Peretti-Watel P, Raude J, Sagaon-Teyssier L, et al. Attitudes toward vaccination and the H1N1 vaccine: poor people's unfounded fears or legitimate concerns of the elite? *Soc Sci Med*. 2014;109:10–18.
 80. Larson HJ, Clarke RM, Jarrett C, et al. Measuring trust in vaccination: a systematic review. *Hum Vaccin Immunother*. 2018;14(7):1599–1609.
 81. Giddens A. *Modernity and self-identity: self and society in the late modern age*. Stanford: Stanford University Press; 1991.
 82. Ward JK, Alleaume C, Peretti-Watel P. The French public's attitudes to a future COVID-19 vaccine: the politicization of a public health issue. *Soc Sci Med*. 2020;265:113414.
 83. Balogh S, Papp R, Busa C, et al. Role of health care professionals in preventative activities and vaccination programs during outbreaks. *Acta Microbiol Immunol Hung*. 2016;63(4):365–372.
 84. Mignot A, Wilhelm M-C, Valette A, et al. Behavior of nurses and nurse aides toward influenza vaccine: the impact of the perception of occupational working conditions. *Hum Vaccin Immunother*. 2020;16(5):1125–1131.
 85. Brownlie J, Howson A. 'leaps of faith' and MMR: an empirical study of trust. *Sociology*. 2005;39(2):221–239.
 86. Verger P, Scronias D. Changes in general practitioners' attitudes toward COVID-19 vaccination after first interim results: a longitudinal approach in France. *Hum Vaccin Immunother*. 2021;17(10):3408–3412.
 87. de Almeida Neto AC. Understanding motivational interviewing: an evolutionary perspective. *Evolutionary Psychological Science*. 2017;3(4):379–389.
 88. Colgrove J. Vaccine refusal revisited - the limits of public health persuasion and coercion. *N Engl J Med*. 2016;375(14):1316–1317.
 89. Gualano MR, Corradi A, Voglino G, et al. Healthcare workers' (HCWs) attitudes towards mandatory influenza vaccination: a systematic review and meta-analysis. *Vaccine*. 2021;39(6):901–914.
 90. Short E, Zimmerman P-A, van de Mortel T. Barriers associated with mandatory influenza vaccination policies for healthcare workers: an integrative review. *Journal of Infection Prevention*. 2020;21(6):212–220.
 91. Brehm SS, Brehm JW. *Psychological reactance: a theory of freedom and control*. New York: Academic Press; 1981.
 92. Betsch C, Böhm R. Detrimental effects of introducing partial compulsory vaccination: experimental evidence. *Eur J Public Health*. 2016;26(3):378–381.
 93. Sprengholz P, Felgendreiff L, Böhm R, et al. Vaccination policy reactance: predictors, consequences, and countermeasures. *J Health Psychol*. 2021 13591053211044535 DOI: 10.1177/13591053211044535
 94. Kernéis S, Jacquet C, Bannay A, et al. Vaccine education of medical students: a nationwide cross-sectional survey. *Am J Prev Med*. 2017;53(3):e97–e104.
 95. Pelly LP, Pierrynowski Macdougall DM, Halperin BA, et al. THE VAXED PROJECT: an assessment of immunization education in Canadian Health Professional programs. *BMC Med Educ*. 2010;10(1):86.
 96. Vorsters A, Tack S, Hendrickx G, et al. A summer school on vaccinology: responding to identified gaps in pre-service immunisation training of future health care workers. *Vaccine*. 2010;28(9):2053–2059.
 97. Sarnquist C, Sawyer M, Calvin K, et al. Communicating about vaccines and vaccine safety: what are medical residents learning and what do they want to learn? *J Public Health Manag Pract*. 2013;19(1):40–46.
 98. Shen SC, Dubey V. Addressing vaccine hesitancy: clinical guidance for primary care physicians working with parents. *Can Fam Physician*. 2019;65(3):175–181.
 99. Motivational interviewing in the maternity ward for the immunization of Children (EMMIE) program [Internet]. cited 2021 Dec 10; Available from 2021 Dec 10 <https://www.quebec.ca/en/health/advice-and-prevention/vaccination/motivational-interviewing-in-maternity-for-the-immunization>.

100. The COVID-19 vaccine communication handbook [Internet]. hackMD. [cited 2021 Dec 10]. Available from 2021 Dec 10: <https://hackmd.io/@scibehC19vax/home>
101. JITSUVAX: jiu jitsu with misinformation in the age of COVID. [Internet]. Notion. cited 2021 Dec 10]. Available from 2021 Dec 10: <https://jitsuvax.notion.site/jitsuvax/JITSUVAX-97638f0709a249f18de1f3e036526600>.
 - **Ongoing EU project dedicated to measuring VH in HCPs around Europe using a common, standardized tool; followed by the training of HCPs to decommon, standardized tool; followed by the training of HCPs to debunk misinformation with their patients.**
102. Vallée-Tourangeau G, Promberger M, Moon K, et al. Motors of influenza vaccination uptake and vaccination advocacy in health-care workers: development and validation of two short scales. *Vaccine*. 2018;36(44):6540–6545.
103. Chen I-H, Ahorsu DK, N-y K, et al. Adapting the motors of influenza vaccination acceptance scale into the motors of COVID-19 vaccination acceptance scale: psychometric evaluation among mainland Chinese university students. *Vaccine*. 2021;39(32):4510–4515.
104. Opel DJ, Heritage J, Taylor JA, et al. The architecture of provider-parent vaccine discussions at health supervision visits. *Pediatrics*. 2013;132(6):1037–1046.
105. Dubé E, Gagnon D, MacDonald NE, et al. Strategies intended to address vaccine hesitancy: review of published reviews. *Vaccine*. 2015;33(34):4191–4203.
106. Ward JK, Colgrove J, Verger P. France's risky vaccine mandates. *Science*. 2017;358(6362):458–459.
107. World Health Organization. Development of tools to measure behavioural and social drivers (BeSD) of vaccination. PROGRESS REPORT. 2020 [Internet]. cited 2021 Dec 15]. Available from 2021 Dec 15: https://cdn.who.int/media/docs/default-source/immunization/besd_progress_report_june2020.pdf?sfvrsn=10a67e75_3_s
 - **Report by a WHO working group on the development and validation of tools to measure VH in high and lowWHO working group on the development and validation of tools to measure VH in high and lowincome countries using behavioural and social determinants.**

Appendix 1. Medline search strategy (Ovid SP)

Theme	Search string
Vaccine	*vaccination/ or *mass vaccination"/ or *vaccines/ or *immunization programs"/ or (immuni#ation* or immuni#e* or immuni#ing or vaccin*).ti,ab.
Knowledge, attitudes, behaviors	attitude/ or 'attitude to health'/ or trust/ or uncertainty/ or *Health Knowledge, Attitudes, Practice"/ or *Attitude of Health Personnel"/ or (accept* or adherence or anxiet* or attitude* or barrier* or behavior* or belief* or choice* or compliance or confiden* or decision* or determinant* or dismiss* or factor* or hesita* or intention* or knowledge or mistrust* or motivat* or nonadherence or non-compliance or noncompliance or participat* or perception* or practice* or preference* or reason* or refus* or 'risk perception' or trust* willing*).ti,ab.
Health-care personnel	*Health Personnel"/ or 'Nurses'/ or 'General Practitioners'/ or ('HCP*' or 'HCW*' or ((health or healthcare or nursing or medical or clinical or support or hospital or 'health care') adj1 (personnel or provider* or staff* or worker* or professional* or employee* or student*)) or 'caregiver*' or 'nurse*' or practitioner* or clinician* or specialist* or therapist* or doctor* or physician* or generalist* or 'occupational health' or pe?diatrician or pharmacist* or paramedic* or midwi#e* or gyne?cologist* or obstetrician* or chiropractic* or naturopath* or homeopath*).ti,ab,kf.