Vaccine: X 25 (2025) 100671

Contents lists available at ScienceDirect

Vaccine: X

journal homepage: www.elsevier.com/locate/jvacx

Exploring vaccination literacy and vaccine hesitancy in seven European countries: results from the HLS_{19} population survey

Bakary Cissé [a,1], Aldo Rosano [b,1], Robert Griebler [c], Brigid Unim [d], Chiara Lorini [e], Guglielmo Bonaccorsi [e], Mitja Vrdelja [f], Sophie Fégueux [g], Julien Mancini [a,h,*], Stephan Van den Broucke [i], For the HLS19 Consortium

[a] Aix Marseille Univ, INSERM, IRD, ISSPAM, SESSTIM, Sciences Economiques & Sociales de la Santé & Traitement de l'Information Médicale, Marseille, France
[b] National Institute for the Analysis of Public Policy-INAPP, 00198 Rome, Italy
[c] Austrian National Public Health Institute (Gesundheit Österreich GmbH), Vienna, Austria
[d] Department of cardiovascular, endocrine-metabolic diseases and aging, Istituto Superiore di Sanità, Rome, Italy
[e] Health Literacy Laboratory, Department of Health Science, University of Florence, Florence, Italy
[f] Communication Unit, National institute of Public Health, Ljubljana, Slovenia
[g] Santé publique France, Saint-Maurice, France
[h] APHM, Hop Timone, BioSTIC, Biostatistique et Technologies de l'Information et de la Communication, Marseille, France
[i] Psychological Sciences Research Institute, Université catholique de Louvain, Louvain-la-Neuve, Belgium

ARTICLE INFO

Keywords:
Vaccine hesitancy
Vaccine literacy
Vaccination attitudes
Health literacy survey
European Union

ABSTRACT

Improving Vaccine Literacy (VAC-HL) is a promise strategy to reduce vaccine hesitancy (VH). VAC-HL refers to the individual ability to access, understand, critically appraise, and apply vaccination-related information to make informed decisions about vaccinations for themselves or for others to be vaccinated. This study explores the pathways through which VAC-HL impacts VH.

The analysis was based on data from seven countries of the WHO European Region which implemented the Health Literacy Survey 2019–2021 (HLS_{19}). VH was measured by a proxy for self-reported vaccination behaviour of respondents or their family members (e.g., children) over the past five years, while VAC-HL was assessed using four items stemming from the 47-item health literacy questionnaire used in HLS_{19} (HLS_{19}-Q47). A multilevel structural equation model was applied to examine the mediation role of vaccination attitudes - confidence, complacency, conspiracy beliefs - in the relationship between VAC-HL and VH, controlling for socio-economic confounding factors.

The results showed that individuals with high levels of VAC-HL are less likely to be unvaccinated (OR = 0.67, 95 % CI = 0.64–0.70). The inclusion of mediation variables in the model reduced slightly the association but it remained statistically significant (OR = 0.82, 95 % CI = 0.80–0.83). About 27.10 % of the association between VAC-HL and VH was mediated by confidence, 6.58 % by complacency and 17.30 % by conspiracy.

Enhancing VAC-HL might have a positive effect on restoring confidence in vaccination and reducing complacency and conspiracy beliefs, which are essential for improving vaccination uptake.

1. Background

The development of vaccines represents one of the most significant achievements in human history, preventing an estimated 3.5 to 5 million deaths annually [1]. Vaccination is a fundamental component of primary health care, is recognised as a basic human right, and is one of the most cost-effective health interventions [2]. In addition to protecting individual health, vaccines are crucial in preventing and controlling

Abbreviations: CAPI, Computer-Assisted Personal Interviews; CATI, Computer-Assisted Telephone Interviews; CAWI, Computer-Assisted Web Interviews; GEN-HL, General Health Literacy; HL, Health Literacy; HLS_{19}, European Health Literacy Survey 2019–2021; M-POHL, Action Network on Measuring Population and Organizational Health Literacy; VAC-HL, Vaccine Health Literacy; VH, Vaccine Hesitancy.

* Corresponding author at: UMR1252 SESSTIM (Aix-Marseille Univ), Institut Paoli-Calmettes, 232 Bd Ste Marguerite, BP 156, 13273 Marseille Cedex 9, France.
E-mail address: julien.mancini@univ-amu.fr (J. Mancini).

[1] Contributed equally

https://doi.org/10.1016/j.jvacx.2025.100671
Received 16 March 2025; Received in revised form 23 May 2025; Accepted 28 May 2025
Available online 2 June 2025

infectious disease outbreaks [3].

Despite their undeniable value in mitigating the spread of infectious diseases and reducing hospitalisations and deaths [4], scepticism towards vaccines and vaccination campaigns persists and is on the rise, especially among parents [5,6]. Although there is strong evidence to support the effectiveness and safety of modern vaccines, vaccine hesitancy (VH), defined as the delay or refusal of vaccination even when vaccines are readily available [7], has increased over the past years. Research shows that people's decisions for or against vaccination is shaped by individual and collective experiences, beliefs, knowledge, and situational factors, such as access to vaccination information and healthcare provider attitudes [8–10].

The scepticism and reluctance to get vaccinated intensified during the COVID-19 pandemic, fuelled by the rapid spread of disinformation, particularly through social media platforms [11]. It has been recognised by the World Health Organization (WHO) as one of the top ten global health threats [12]. VH carries significant consequences, both for the individual, such as an increased risk of severe illness, and at the socio-economic level, leading to increased healthcare costs [13,14]. Therefore, it is essential for public health to address the issue of VH, particularly in the post-infodemic context of COVID-19, where conflicting information has likely shaped public perceptions of vaccination [15].

VH is driven by a complex decision-making process influenced by multiple psychological factors [16]. To understand this psychological drivers, the 7Cs model of vaccination readiness [17] describes seven psychological components: confidence, complacency, constraints, calculation, collective responsibility, compliance, and conspiracy. In this study, we focused on a subset to investigate their contribution to vaccination uptake.

Confidence refers to trust in the effectiveness and safety of vaccines, the systems that deliver them, and the motivations of policymakers ensuring vaccine access. A lack of confidence can stem from misinformation, affiliations with anti-vaccine groups, extreme political groups or legitimate concerns about vaccine safety and efficacy.

Complacency occurs when the perceived risk of vaccine-preventable diseases is low, and vaccination is not seen as a necessary preventive measure. This can be influenced by competing life priorities or the success of immunisation programs (herd immunity), which may paradoxically lead to complacency as the risk of disease diminishes.

***Conspiracy* beliefs** about vaccines are among the most widespread medical conspiracy theories [18]. Belief in these theories has been shown to reduce vaccination intentions [19,20]. During the COVID-19 pandemic, belief in related conspiracy theories was found to be negatively correlated with confidence in vaccines and willingness to vaccinate [21,22]. Research also indicates that exposure to COVID-19 conspiracy theories reduces public support for government health regulations and decreases adherence to protective behaviours [23], indicating a significant negative impact on vaccination readiness.

One promising approach to combat VH is to improve Vaccine Literacy (VAC-HL), which refers to the extent to which people are able to access, understand, critically appraise, and apply vaccination-related information to make informed decisions about vaccinations for themselves or for others to be vaccinated. It arises from the interaction of individual competencies with the information and service environment and the motivation that comes with it [24–26]. While VAC-HL is linked to General Health Literacy (GEN-HL), the two concepts only partially overlap. Understanding and appraising the relevance of vaccines requires a unique set of cognitive skills, and even people with high levels of GEN-HL may not have a sufficient understanding of vaccines. Addressing VAC-HL involves not only the dissemination of accurate information about vaccination and immunisation, but also efforts to improve communication and promote community engagement with regard to vaccines. In addition, VAC-HL also has an organizational dimension, which is concerned with the complexities of health systems focused on communication and immunisation practices [27]. Recent systematic reviews examining the relationship between GEN-HL and vaccination behaviour as well as attitudes towards vaccination, from all parts of the world (with more European than American studies) between 2002 and 2021, are inconclusive, as the relationship between HL and vaccination behaviour remains scarcely supported by evidence [26,28]. Despite partially contradictory results, the studies indicate a positive correlation between GEN-HL and vaccination attitudes and behaviour, with higher HL associated with a more positive attitude towards vaccination and a higher uptake of vaccines. Yet, the relationship between VAC-HL and vaccination behaviour remains complex. Many authors argue that there is a mediation role of attitudes towards vaccination, such as confidence and risk perception of vaccination [28–30].

Building on the understanding of VAC-HL and VH, this study seeks to explore the pathways through which VAC-HL impacts vaccination behaviour (VAC-BEHAV; as a proxy for VH [31,32]), using structural equation modelling (SEM). The model suggests: (1) a direct effect between VAC-HL and VAC-BEHAV, and (2) an indirect influence of VAC-HL on VAC-BEHAV through factors such as vaccine confidence (VAC-CONF), complacency (VAC-COMPL), and conspiracy beliefs (VAC-CONS) (Fig. 1).

2. Materials and methods

2.1. Study design and sampling

The analysis was based on data from the Health Literacy Survey 2019–2021 (HLS_{19}) [33], a project of the WHO Action Network on Measuring Population and Organizational Health Literacy (M-POHL) [34].

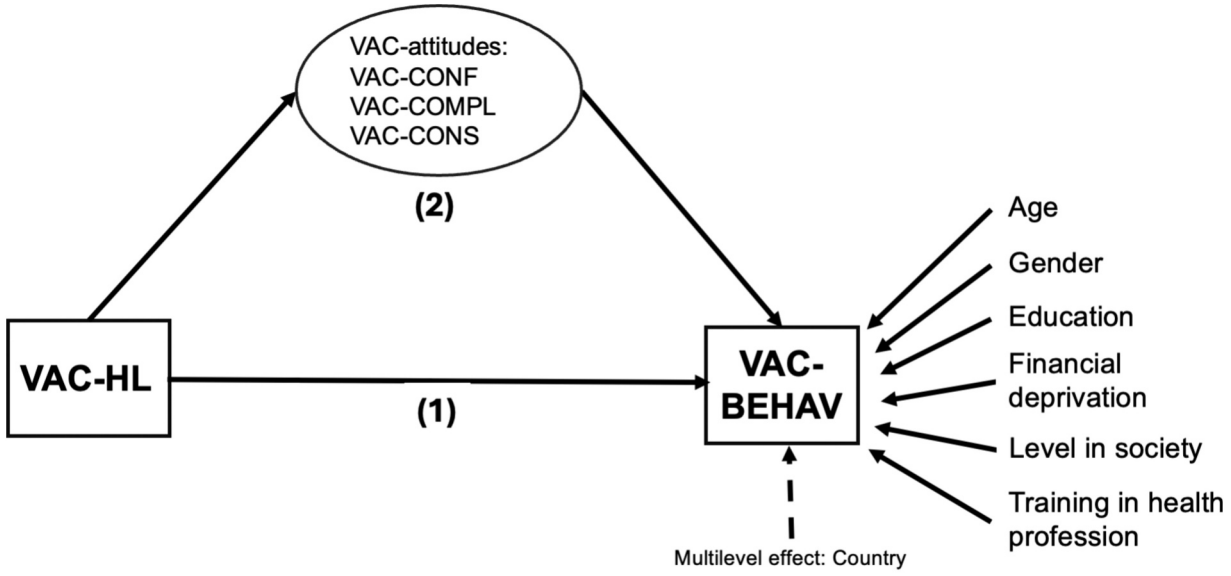
The study population was defined as all permanent residents aged 18 and above living in private households. The study considers data from seven countries of the WHO European Region which implemented the HLS_{19} optional package on VAC-HL, with a minimum sample size of 1000 respondents: Austria (AT), Belgium (BE), Czech Republic (CZ), Hungary (HU), Ireland (IE), Portugal (PT), and Slovenia (SI). In total 15,855 completed surveys were included in the study. National sample sizes varied as follows: AT: 2967, BE: 1000, CZ: 1599, HU: 1195, IE: 4487, PT: 1247 and SI: 3360. The participating countries used a multistage random sampling procedure or quota sampling, and most countries stratified samples by gender, age group, population density, and geographical areas/regions. The methods of data collection included computer-assisted telephone interviews (CATI) in AT, HU, IE, and PT; computer-assisted web interviews (CAWI) in BE; CAWI + CATI in CZ; and computer-assisted personal interviews (CAPI) + CAWI in SI. Due to the COVID-19 pandemic, the original time frame for collecting data was extended, and the data collection phase lasted from July 2019 to January 2021 (appendix 1) [35].

2.2. Measures

VAC-HL was measured with four items (item 19, 22, 26 and 29) stemming from the HLS_{19}-Q47 [35,36]:

- COREHL19…to find information on recommended vaccinations for you or your family?
- COREHL22 …to understand why you or your family may need vaccinations?
- COREHL26 …to judge which vaccinations you or your family may need?
- COREHL29…to decide if you should have a flu vaccination?

These questions investigate the process dimensions of finding, understanding, judging, and applying vaccination information using a 4-point Likert scale with the following options: very easy (=4), easy (=3), difficult (=2), very difficult (=1). The VAC-HL score was calculated as the average of the numerical values of items and transformed to a scale from 0 to 100. A higher score indicates a higher level of VAC-HL.



(1) direct effect between VAC-HL and VH: ''reduced" model
(2) indirect effect between VAC-HL and VH: 'full" model

Fig. 1. Hypothesis multilevel SEM showing causal pathway from VAC-HL to VAC-BEHAV.

If one of the items did not contain valid responses, the score was set to 'missing'. The factorial validity of the HLS_{19}-VAC instrument was confirmed by confirmatory factor analyses and Rasch analyses for all countries, showing that the HLS_{19}-VAC questionnaire is a unidimensional instrument that measures VAC-HL as distinct from GEN-HL [35].

In addition to the four VAC-HL items, the HLS_{19} optional package on VAC-HL included one item on vaccination behaviour during the previous five-year period (VAC-BEHAV), four items referring to personal confidence in vaccinations (VAC-CONF), one item on the risk of getting a disease for which a vaccine exists (VAC-COMPL), three items on myths about the possible risks of getting vaccinated (VAC-CONS) (Table 1).

The question on vaccination behaviour focuses on the behaviour of the respondent and family members and thus indirectly refers to the basic attitude towards vaccination. The period of 5 years makes the necessity of vaccinations for family members very likely and allows conclusions on vaccination refusal.

In addition to VAC-HL, socio-demographic and socio-economic information were also collected in the study to characterise the population and control for potential confounding factors [35]:

- Sex: male vs female.
- Age: 18–25, 26–35, 36–45, 46–55, 56–65, 66–75, 76+
- Education level: primary, secondary, tertiary
- Training in health: yes vs no
- Financial deprivation: continuous value from 0 to 100

2.3. Statistical analyses

The analysis of individual items and composite scores (VAC-HL, VAC-BEHAV, VAC-CONF, VAC-COMPL, VAC-CONS) was first performed using the frequencies distributed by country.

Second, a multilevel (identified by the contextual country effect) SEM was used to investigate the mediation role of vaccination attitudes (confidence/complacency/conspiracy) in the relationship between VAC-HL and VAC-BEHAV, controlling for covariates which may influence both an individual's health literacy but also directly their attitude towards vaccination, such as gender, age, education, financial deprivation, and being trained in a health profession [37,38] (Fig. 1). We

Table 1
Vaccination behaviour and components of vaccination readiness.

Components	Short version item(s) / *Responses*	Computation of scores
VAC-BEHAV	Have you, your children or has someone in your family had any vaccinations in the last five years? / *1 = yes; 2 = no*	The percentages of responses to the question
VAC-CONF	- Vaccinations are important to protect myself and my children / *1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree* - Overall, I think vaccinations are safe / *1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree* - Overall, I think vaccinations are effective / *1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree* - Vaccinations are important to prevent the spread of (severe) diseases / *1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree*	The items were inverted (strongly agree = 4; agree = 3; disagree = 2; strongly disagree = 1), summed, and then divided by the number of items (4). This results in a score with values between 1 and 4. A corresponding mean score can then be interpreted along the agreement scale. A higher score value signifies a higher level of confidence.
VAC-COMPL	In general, how high do you estimate the risk of developing a disease that you can be vaccinated against, if you are not vaccinated? / *1 = very high; 2 = high; 3 = low; 4 = very low*	The percentages of responses to the question, scaled from 'very high' to 'very low'.
VAC-CONS	- Vaccines overload and weaken the immune system / *1 = true; 0 = false* - Vaccines can cause the diseases against which they protect / *1 = true; 0 = false* - Vaccines often produce serious side effects (other than the normal and temporary reactions in the first few days) / *1 = true; 0 = false*	Conspiracy score = VAC-CONS1re + VAC-CONS2re + VAC-CONS3re 0 = no conspiracy; 3 = highest conspiracy

VAC-BEHAV: vaccination behaviour; VAC-CONF: confidence; VAC-COMPL: complacency; VAC-CONS: conspiracy

verified that the correlation between different covariates was not significant (appendix 2). In nested logit models, coefficients between reduced (without mediators) and full (with mediators) models are not directly comparable due to non-linear scaling issues. To address this limitation, we applied the KHB decomposition method developed by Karlson, Holm, and Breen [39], enabling an unbiased estimate of the mediation effect by comparing the estimated coefficient of the key variable (VAC-HL) between a "reduced" model (without hypothesized mediator variables) and a "full" model which includes this mediator variables.

The significance level was set at 5 % for all statistical analyses. Analyses were carried out with Stata: statistical software for data science, version 18 [40].

2.4. Ethics approval

The study was approved in countries where national regulations provide for a review of ethical requirements (e.g. through university ethics committees) (appendix 3). In the absence of such requirements and ethics committees, countries were obliged to follow national ethical guidelines for population surveys and to submit their protocol to any relevant committee at national level. In addition, each country participating in HLS_{19} was required to [41]:

- comply with applicable national data protection legislation (EU countries were additionally required to comply with the EU General Data Protection Regulation (GDPR) (Regulation (EU) 2016/6792016).
- guarantee that study participants are fully informed about the research and the procedures in place to allow them to easily withdraw from the study.
- use written and/or oral procedures for informed consent.
- fully document their national procedures.

3. Results

3.1. Vaccination literacy

Higher levels of VAC-HL were observed in Ireland (79.3) and Austria (77.3), while the Czech Republic (73.1) and Belgium (71.1) reported lower VAC-HL scores (Fig. 2). Overall, the heterogeneity in VAC-HL across the seven countries was relatively low (from 71.1 to 79.3), indicating some consistency in VAC-HL levels within each country.

3.2. Vaccination behaviour (VAC-BEHAV)

Portugal (89.3 %), Austria (76.1 %), Ireland (72.8 %) and Belgium (71.3 %) show higher percentages of self-reported vaccination uptake over the last 5 years, while Hungary (53.3 %), Slovenia (59.3 %) and the Czech Republic (68.9 %) show lower vaccination rates (Fig. 3).

3.3. Confidence (VAC-CONF)

Confidence scores in vaccination varied across countries: Ireland (3.6), Austria (3.5), and Belgium (3.4) reported the highest levels of confidence, while the Czech Republic (3.2) and Slovenia (3.1) had the lowest confidence scores (Fig. 3).

3.4. Complacency (VAC-COMPL)

Complacency levels were particularly high in Austria, Belgium, Hungary, the Czech Republic, and Slovenia, where over 40 % of respondents fell into the "low" or "very low" categories. In contrast, Portugal (13.5 %) and Ireland (31.2 %) showed lower levels of complacency, with fewer respondents reporting complacent attitudes towards vaccination (Fig. 3).

3.5. Conspiracy believes (VAC-CONS)

The countries with the highest percentages of respondents who believe vaccination myths to be true were Slovenia (41.0 %), Hungary

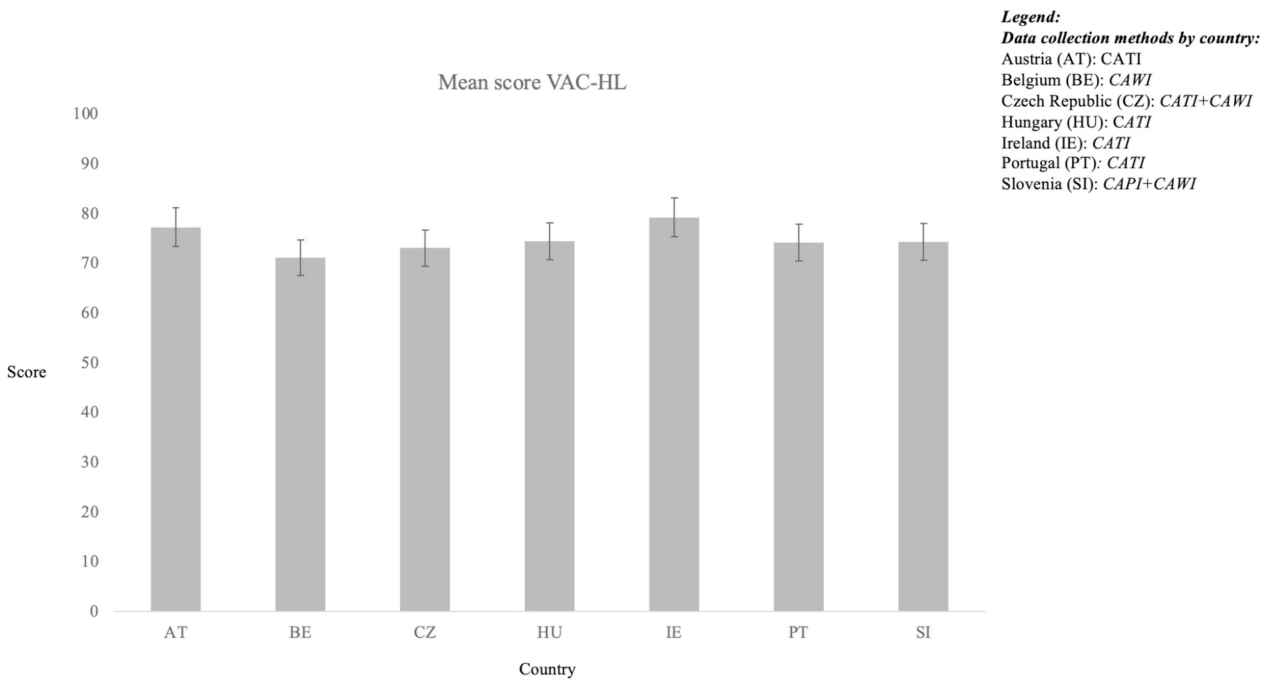


Fig. 2. Vaccination Literacy *across the seven countries.*

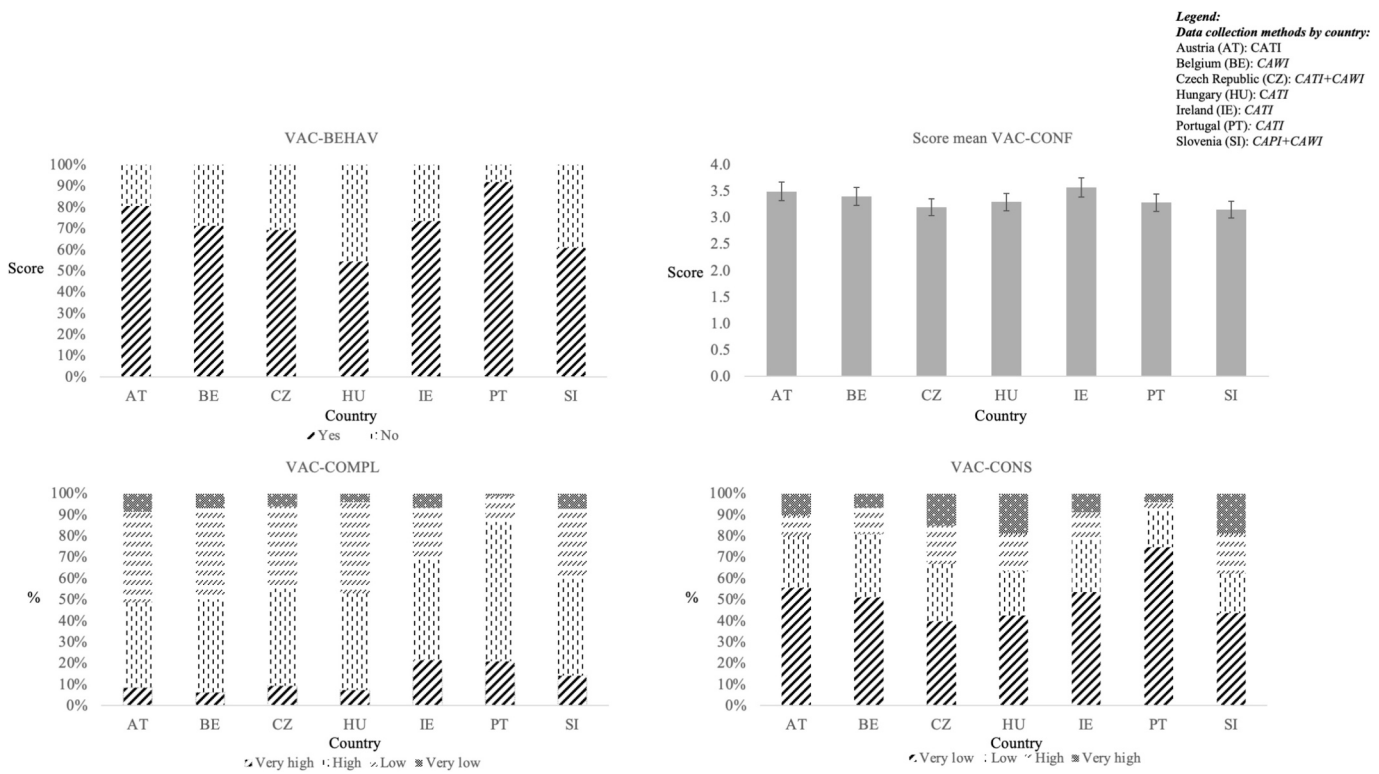


Fig. 3. Vaccine hesitancy across the seven countries.

(36.7 %), and the Czech Republic (33.1 %). In contrast, Portugal (91.9 %), Belgium (80.9 %), Austria (79.4 %) and Ireland (78.2 %) showed lower levels of conspiracy behaviour, reflecting a more positive attitude towards vaccinations in those countries (Fig. 3).

3.6. Multilevel structural equation model

The multilevel SEM indicated that several variables were significantly associated with the risk of respondents or family members (e.g., children) not having been vaccinated in the past five years (Table 2). Women were more likely than men to report vaccinations. In addition, people with higher levels of education, especially those with secondary or higher education, were more likely to report vaccinations in the last five years than those with only primary education. Better knowledge about vaccines was also associated with a lower risk of no vaccinations.

An increased risk of no vaccinations was found for people aged 46 to 55 and 56 to 65 compared with younger people. Moreover, people who are not trained in a healthcare profession were also more likely to report no vaccinations. Financial deprivation did not show a significant effect.

Variance components indicate that there was significant variation both at individual and country level.

3.7. Mediation analysis

By using the KHB-method, we were able to decompose the total effect of vaccination attitude into direct and indirect effects. The initial model, without the inclusion of mediating variables (referred to as the "reduced" model), indicated a statistically significant association between VAC-HL levels and hesitancy VAC-BEHAV (OR = 0.67, 95 % CI = 0.64–0.70). This suggests that individuals with high levels of VAC-HL are less likely to report no vaccinations. When mediation variables (VAC-CONF, VAC-COMPL, VAC-CONS) were introduced into the model, the association between VAC-HL and vaccine hesitancy was reduced slightly but remained statistically significant (OR = 0.82, 95 %CI = 0.80–0.83). About 27.10 % of the association between VAC-HL and the risk of not being vaccinated was mediated by confidence, 6.58 % by complacency and 17.30 % by conspiracy. Overall, the inclusion of vaccination attitude in the model as mediation factor, significantly reduces the risk of not being vaccinated by 50.9 % (Table 3).

Table 2
Factors associated with reporting no vaccination in the last five years.

Variables		aOR[1]	[95 % Confidence Interval]	
Sex	Male (ref)	1		
	Female	0.84	0.77	0.92
Age class	18–25 (ref)	1		
	26–35	0.87	0.72	1.06
	36–45	0.62	0.51	0.76
	46–55	1.25	1.04	1.49
	56–65	1.35	1.13	1.62
	66–75	1.08	0.89	1.31
	76+	0.97	0.76	1.25
Education	Primary (ref)	1		
	Secondary	0.87	0.77	0.99
	Tertiary	0.70	0.62	0.80
Financial deprivation	Continuous	1.00	0.99	1.01
Trained in a healthcare profession	Yes (ref)			
	No	1.50	1.31	1.73
Vaccine literacy (VAC-HL)	Continuous	0.73	0.68	0.79
Confidence (VAC-CONF)	Continuous	0.59	0.54	0.64
Complacency (VAC-COMPL)	Very High (ref)	1		
	High	1.11	0.96	1.29
	Low	1.57	1.35	1.83
	Very Low	1.64	1.32	2.03
Conspiracy (VAC-CONS)	Very high (ref)	1		
	High	0.70	0.59	0.82
	Low	0.52	0.45	0.61
	Very Low	0.41	0.35	0.47
Intercept		7.75	4.23	14.22
Variance components	Country	0.32	0.11	0.96

[1] Adjusted Odds Ratio

Table 3
Decomposition of the mediation effect of vaccine attitudes (VAC-CONF, VAC-COMPL, VAC-CONS) on the relationship between VAC-HL and VAC-BEHAV.

Outcome	OR	[95 % Confidence Interval]	
Total effect	0.67	0.64	0.70
Direct effect	0.82	0.78	0.86
Indirect effect	0.82	0.80	0.83

Summary of confounding	Confounding ratio	Confounding percent
VAC-HL	2.03	50.9
Components of difference	**Coefficient**	**Mediating %**
Confidence (VAC-CONF)	−0.108	27.10
Complacency (VAC-COMPL)	−0.026	6.58
Conspiracy (VAC-CONS)	−0.069	17.30

4. Discussion

The findings from this study allowed to identify important factors influencing VAC-BEHAV (vaccination behaviour) in seven European countries, particularly VAC-HL (vaccine literacy), VAC-CONF (confidence), VAC-COMPL (complacency) and VAC-CONS (conspiracy beliefs).

The study shows that higher levels of VAC-HL were associated with a lower reporting of no vaccinations in the past five years. This is consistent with previous research by Sørensen et al. [42] and Lorini et al. [43], which found that higher levels of GEN-HL improve health outcomes, including vaccine adherence. By comparison with GEN-HL, VAC-HL is specifically designed for the understanding, evaluation and application of vaccination information [44]. This distinction highlights the importance of targeted interventions to improve VAC-HL as a strategy for improving vaccination uptake. Our results show that interventions focusing on VAC-HL may be more effective in improving vaccination behaviour, because they directly address the cognitive and practical requirements of vaccination decision-making. Low heterogeneity in VAC-HL across countries suggests that efforts to increase VAC-HL have been implemented consistently, but that countries with lower VAC-HL, such as Belgium and the Czech Republic, may benefit from more targeted interventions.

The observed geographical differences in vaccine uptake, in which countries such as Portugal, Austria and Belgium reported higher vaccination rates than Hungary, Slovenia and Czech Republic, support findings from de Figueiredo et al. [45], and Verger et al. [31], who identified regional disparities in vaccine acceptance due to the previous history of vaccine-related adverse events, cultural, political and historical factors. Lower vaccination rates in Hungary and Slovenia may be influenced by a greater societal distrust of healthcare institutions [46,47], emphasizing the need for region specific strategies to address vaccination resistance. However, it is important to note that the question on vaccination behaviour was asked during the early stages of the COVID-19 pandemic, when there was a major disruption to immunisation services worldwide [48]. In the WHO European Region, routine vaccination coverage for the third dose of the diphtheria-tetanus-pertussis vaccine (DTP3) dropped from 95 % in 2019 to 94 % in 2020 [49]. The main reasons for this drop were public fears, movement restrictions, supply disruptions and reduced health workers availability.

High levels of VAC-COMPL were found in Austria, Belgium, Hungary, the Czech Republic, and Slovenia, where more than 40 % of respondents were classified as having 'high' or 'very high' complacency. In areas with established vaccination programmes, VAC-COMPL often arises from a perceived lower risk of contracting vaccine-preventable diseases. This underscores the need for ongoing public health initiatives that reinforce the importance of vaccination, even in populations with low disease incidence. Despite successful efforts to eradicate certain diseases, low levels of VAC-COMPL in countries like Portugal and Ireland underline the effectiveness of public health campaigns emphasizing the continued need for vaccines.

VAC-CONS levels in Slovenia, Hungary and the Czech Republic, which correlate with lower VAC-BEHAV, mirror the findings of Hornsey et al. [20]. Belief in vaccine-related conspiracy theories has consistently been shown to reduce vaccination intentions. Countries where conspiracy beliefs are less prevalent, such as Portugal, Belgium, and Ireland, have higher vaccine uptake rates, suggesting a more positive attitude towards vaccination. This suggests that efforts to demystify vaccines, improve media education and combat misinformation, particularly on social media, could be essential in reducing VH (vaccine hesitancy) in regions prone to conspiracy beliefs.

The influence of COVID-19 on VH in terms of VAC-CONF, VAC-COMPL and VAC-CONS has been documented extensively [50–52]. Misinformation during the pandemic probably contributed to an increase in conspiracy beliefs. Countries with better public health communication strategies, with lower levels of complacency and conspiracy beliefs, managed to maintain higher vaccination rates [53]. These results demonstrate the importance of transparency in communication and the necessity to quickly fight misinformation in the context of a public health crisis. Strategies should therefore be based on a country-dependent approach, considering the level of health literacy and, most importantly, attitudes towards vaccination. In practical terms, for countries with the highest resistance to vaccination, such as Hungary, the Czech Republic and Slovenia, it might be appropriate to develop multilingual, culturally appropriate vaccine education materials. This could include infographics or short videos that clearly explain the benefits and safety of vaccines, to be distributed in public transport stations, waiting rooms in hospitals, schools, and universities. This could also include reactive campaigns via social media (Instagram, TikTok) to counteract misinformation about vaccines. These campaigns could specifically target younger adults and use credible influencers to boost trust and promote messages based on scientific evidence. An intervention illustrating these approaches is the "One Vax Two Lives" campaign conducted in the United States [54]. Its aim was to reduce vaccine hesitancy during pregnancy, and the results have been encouraging. The campaign was based on the diffusion of videos and infographics in nine languages, promoted by medical staff and trusted influencers, both in local communities and on social media such as Facebook and Instagram.

The findings concerning demographic factors associated with VH showed that women and individuals with a higher level of education were more likely to report no vaccinations in the past five years, aligning with results from the *Vaccine Confidence Project* [45]. However, these results should be interpreted with caution, as the gender difference may be influenced by various factors not included in this study, like the type of vaccine and race [55,56]. In general, as discussed by Eckel et Grossman [57], women tend to be more risk averse than men, which may explain their preference for the relative safety offered by vaccines compared with the known risks of diseases that can be avoided by immunisation. Also, middle-aged adults (aged 46–65) and individuals without healthcare training were more likely to report no vaccinations in the past five years. These results align with global trends [58,59], where individuals with lower education and older age groups show higher VH. This suggests that future interventions to strengthen VAC-HL should prioritize individuals with lower education level, middle-aged adults, and men.

Using multilevel SEM to assess the mediating role of vaccination attitudes (VAC-CONF, VAC-COMPL, VAC-CONS) in the relationship between VAC-HL and VAC-BEHAV demonstrated that these attitudes served as significant mediators. This approach provided a more nuanced understanding of VH. However, although we conducted a multilevel analysis across countries to capture the particularities of each country and the specificity of their survey methods, it is important to mention that the timing of the survey in different countries might be a confounding factor for the VAC-BEHAV due to the COVID-19 crisis. In this study, we were unable to examine the other psychological factors of the

7Cs model due to space limitation in the HLS_{19} questionnaire. We therefore focused on three of the 5Cs that were expected to be more affected by VAC-HL and were of particular interest to the HLS_{19} consortium. Future research is needed gain a deeper understanding of the other factors, particularly calculation and collective responsibility. Also, the lack of precision of our variable of interest (VAC-BEHAV), which did not discriminate between family members, might reduce the accuracy of the results. Therefore, the results presented must be considered exploratory, and future research should use more sensitive measures of VAC-BEHAV. Finally, cross-sectional studies such as this one are generally limited in their ability to analyse causal factors. Longitudinal studies would be more appropriate to provide evidence on this issue.

5. Conclusion

This large study in seven European countries supported the hypothesis that VAC-HL might have a significant positive impact on the adoption of favourable vaccination behaviour. Thus, improving VAC-HL might have a positive effect on restoring confidence in vaccination and reducing complacency and conspiracy beliefs, which are essential for improving vaccination uptake. Future public health strategies should take these variables into account to effectively reduce VH, adapting approaches to the specific needs of each country.

CRediT authorship contribution statement

Bakary Cissé: Writing – review & editing, Writing – original draft, Validation, Conceptualization. **Aldo Rosano:** Writing – review & editing, Validation, Formal analysis, Conceptualization. **Robert Griebler:** Writing – review & editing, Validation, Methodology, Conceptualization. **Brigid Unim:** Writing – review & editing, Validation, Conceptualization. **Chiara Lorini:** Writing – review & editing, Validation, Conceptualization. **Guglielmo Bonaccorsi:** Writing – review & editing, Validation, Conceptualization. **Mitja Vrdelja:** Writing – review & editing, Validation, Conceptualization. **Sophie Fégueux:** Writing – review & editing, Validation. **Julien Mancini:** Writing – review & editing, Validation, Conceptualization. **Stephan Van den Broucke:** Writing – review & editing, Validation, Conceptualization.

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Institutional review board statement

Ethical requirements have been met in all seven countries. For more information about ethical considerations, data protection, and informed consent by country, please see *International Report on the methodology, results and recommendations of the European Health Literacy Population Survey 2019–2021 (HLS_{19}) of M-POHL* (https://m-pohl.net/HLS19ResultsandPublications) and Appendix 2.

Funding

This research received no external funding, but the data collection was supported either by ministries of health, university, public health institutes or insurance funds in the different countries. AT: The Austrian Health Literacy Survey was commissioned and financed by the Austrian Federal Health Agency and the Federation of Austrian Social Insurance Institutions. BE: The Belgium HLS_{19} was funded by the Université catholique de Louvain, Louvain-la-Neuve. CZ: Data collection was funded by (all seven) Czech health insurance funds. HU: The research was supported by the Ministry of Human Capacities, Hungary (IV/956–4/2020/EKF). IE: The Irish HLS_{19} was funded by the Department of Health, Dublin. PT: The Portuguese HLS19 was funded by the Direção-Geral da Saúde, Lisbon. SI: The national survey of Health literacy in Slovenia took place within the framework of the project Increasing health literacy in Slovenia-ZaPiS, which is co-financed by the Republic of Slovenia in the amount of 20 % of the value and the European Union from the European Social Fund in the amount of 80 % of the value. Additionally, Bakary Cissé is personally supported by the Aix-Marseille University PhD Programme.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to acknowledge The International Coordination Centre (ICC) of the HLS_{19} project. We would also like to thank all national HLS_{19} team members who contributed to the HLS_{19} project, and to the principal investigators and policy representatives of the seven countries for organizing the HLS_{19} project in their country and providing data for this article.

Appendix A. Survey dates of seven countries

Country	Mode of Data Collection	Period of Data Collection
AT	CATI	16 March–26 May 2020
BE	CAWI	30 January–28 February 2020 1–26 October 2020 15 August–30 November 2020
CZ	CATI, CAWI	10–24 November 2020
HU	CATI, CAPI (self-administered)	2–20 December 2020
IE	CATI	July 2019 and February 2020
PT	CATI	20 December 2020–13 January 2021
SI	CAPI+CAWI	9–15 March 2020 9 June 2020–10 August 2020

Appendix B. Covariates correlation

	Gender	Age class	Financial deprivation	Trained in health profession	VAC-HL
Gender	1				
Age class	−0.2291	1			
Financial deprivation	−0.0018	−0.2190	1		
trained in a health profession	0.0382	−0.1318	0.0368	1	
VAC-HL	0.0466	0.0079	−0.1706	−0.0602	1

Interpretation:

- High correlation: Values between ±0.50 and ± 1 suggest a strong correlation.
- Moderate correlation: Values between ±0.30 and ± 0.49 indicate a moderate correlation.
- Low correlation: Values below ±0.29 are considered a weak correlation.
- No correlation: value of zero implies no relationship.

Appendix C. Details of ethical approval, compliance with data protection rules, and informed consent

	AT	BE	CZ	HU	IE	PT	SI
Ethical approval needed?	–	–	–	x	x	x	x
Ethical approval obtained?	–	–	–	x	x	x	x
Compliance with data protection ensured?	x	x	x	x	x	x	x
Informed consent obtained?	x	x	x	x	x	x	x
Details on ethical approval				Approval obtained by the Medical Research Council Scientific and Research Committee, Hungary, IV/10181–3/2020/EKU, 8 Dec 2020.	Approval obtained by National Research Ethics Committee COVID-19.	Approval obtained by the Institutional Review Board of CIMAD—Centro de Investigação em Marketing e Análise de Dados do Instituto Superior de Contabilidade e Administração da Universidade de Aveiro, on 1 March 2021 and the CEDIC—Commission for Ethics and Deontology in Scientific Research.	Approval obtained by the Slovenian Medical Ethics Committee (No. 0120–373/2020/6)

'x' = yes; '- '= no

In this study Austria, Belgium and the Czech Republic did not require ethical approval. In fact, in this countries, ethical approval may not be required for certain types of research that involve human participants, particularly when the studies are non-invasive and involve minimal risk, such as anonymous surveys or observational studies.

AT: https://www.meduniwien.ac.at/web/en/ueber-uns/ethikkommission/

BE: https://www.fwo.be/en/about-fwo/research-policy/research-ethics/

CZ: https://www.muni.cz/en/about-us/organizational-structure/boards-and-committees/research-ethics-committee/ethics-review

Data availability

Information about data supporting reported results can be found on the M-POHL webpage (https://m-pohl.net/Design_Methods).

References

[1] Vaccines and immunization. https://www.who.int/health-topics/vaccines-and-immunization; 2024.

[2] Immunization as an essential health service: guiding principles for immunization activities during the COVID-19 pandemic and other times of severe disruption. https://iris.who.int/bitstream/handle/10665/336542/9789240014695-eng.pdf; 2025.

[3] Ellwanger JH, da Veiga ABG, de Kaminski VL, Valverde-Villegas JM, de AWQ Freitas, JAB Chies. Control and prevention of infectious diseases from a One Health perspective. Genet Mol Biol 2025;44(1 Suppl 1):e20200256.

[4] Rodrigues CMC, Plotkin SA. Impact of vaccines; health, economic and social perspectives. Front Microbiol 2020;11:1526.

[5] Gowda C, Dempsey AF. The rise (and fall?) of parental vaccine hesitancy. Hum Vaccin Immunother 2013;9(8):1755–62.

[6] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine sept 2013;31(40):4293–304.

[7] Sage-working-group-revised-report-vaccine-hesitancy.pdf. https://cdn.who.int/media/docs/default-source/immunization/sage/2014/october/sage-working-group-revised-report-vaccine-hesitancy.pdf?sfvrsn=240a7c1c_4; 2025.

[8] Thomson A, Robinson K, Vallée-Tourangeau G. The 5As: A practical taxonomy for the determinants of vaccine uptake. Vaccine 2016;34(8):1018–24.

[9] Dubé E, Laberge C, Guay M, Bramadat P, Roy R, Bettinger J. Vaccine hesitancy: an overview. Hum Vaccin Immunother 2013;9(8):1763–73.

[10] MacDonald NE, SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: definition, scope and determinants. Vaccine 2015;33(34):4161–4.

[11] Ferreira Caceres MM, Sosa JP, Lawrence JA, Sestacovschi C, Tidd-Johnson A, Rasool MHU, et al. The impact of misinformation on the COVID-19 pandemic. AIMS. Public Health 2022;9(2):262–77.

[12] Galagali PM, Kinikar AA, Kumar VS. Vaccine hesitancy: obstacles and challenges. Curr Pediatr Rep 2022;10(4):241–8.

[13] Tenforde MW, Patel MM, Ginde AA, Douin DJ, Talbot HK, Casey JD, et al. Effectiveness of SARS-CoV-2 mRNA Vaccines for Preventing Covid-19 Hospitalizations in the United States. Clin Infect Dis 2022 May;3(74(9):1515–24. https://doi.org/10.1093/cid/ciab687.

[14] Mullooly JP, Bennett MD, Hornbrook MC, Barker WH, Williams WW, Patriarca PA, et al. Influenza vaccination programs for elderly persons: cost-effectiveness in a health maintenance organization. Ann Intern Med 1994;121(12):947–52.

[15] Chirico F, Teixeira da Silva JA. Evidence-based policies in public health to address COVID-19 vaccine hesitancy. Future Virol 2025. https://doi.org/10.2217/fvl-2022-0028.

[16] Bussink-Voorend D, Hautvast JLA, Vandeberg L, Visser O, Hulscher MEJL. A systematic literature review to clarify the concept of vaccine hesitancy. Nat Hum Behav déc 2022;6(12):1634–48.

[17] Geiger M, Rees F, Lilleholt L, Santana AP, Zettler I, Wilhelm O, et al. Measuring the 7Cs of vaccination readiness. Eur J Psychol Assess juill 2022;38(4):261–9.

[18] Oliver JE, Wood T. Medical conspiracy theories and health behaviors in the United States. JAMA Intern Med mai 2014;174(5):817–8.

[19] Jolley D, Douglas KM. The effects of anti-vaccine conspiracy theories on vaccination intentions. PLoS One 2014;9(2):e89177.

[20] Hornsey MJ, Harris EA, Fielding KS. The psychological roots of anti-vaccination attitudes: A 24-nation investigation. Health Psychol Off J Div Health Psychol Am Psychol Assoc avr 2018;37(4):307–15.
[21] Freeman D, Loe BS, Chadwick A, Vaccari C, Waite F, Rosebrock L, et al. COVID-19 vaccine hesitancy in the UK: the Oxford coronavirus explanations, attitudes, and narratives survey (oceans) II. Psychol Med 2022;52(14):3127–41.
[22] Romer D, Jamieson KH. Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S. Soc Sci Med 1982;263:113356. oct 2020.
[23] Pummerer L. Belief in conspiracy theories and non-normative behavior. Curr Opin Psychol 2022;47:101394.
[24] Griebler R, Y A, D K, D LZ, G M, L P, et al. Measuring vaccination literacy – an extension of the HLS19-VAC scale. 2024.
[25] Vaccine literacy: A concept analysis - PMC. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9111838/#inm12988-bib-0004; 2025.
[26] Lorini C, Santomauro F, Donzellini M, Capecchi L, Bechini A, Boccalini S, et al. Health literacy and vaccination: A systematic review. Hum Vaccin Immunother 2017;14(2):478–88.
[27] Why is it important to address organisational vaccine literacy? - PMC. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10597065/; 2025.
[28] Siena LM, Isonne C, Sciurti A, De Blasiis MR, Migliara G, Marzuillo C, et al. The Association of Health Literacy with intention to vaccinate and vaccination status: A systematic review. Vaccines 2022;10(11):1832.
[29] Collini F, Bonaccorsi G, Del Riccio M, Bruschi M, Forni S, Galletti G, et al. Does Vaccine Confidence Mediate the Relationship between Vaccine Literacy and Influenza Vaccination? Exploring Determinants of Vaccination among Staff Members of Nursing Homes in Tuscany, Italy, during the COVID-19 Pandemic. Vaccines 2023;11(8):1375.
[30] Jiang F, Zhao Y, Bai J, Yang X, Zhang J, Lin D, et al. Perceived health literacy and COVID-19 vaccine acceptance among Chinese college students: A mediation analysis. PLoS One 2022;17(9):e0273285.
[31] Verger P, Botelho-Nevers E, Garrison A, Gagnon D, Gagneur A, Gagneux-Brunon A, et al. Vaccine hesitancy in health-care providers in Western countries: a narrative review. Expert Rev Vaccines 2022;1(7):909–27. https://doi.org/10.1080/14760584.2022.2056026.
[32] Dong E, Nixon K, Gardner LM. A population level study on the determinants of COVID-19 vaccination rates at the U.S. County level Sci Rep 2024;14(1):4277.
[33] HLS19 | M-POHL - WHO Action Network on Measuring Population and Organizational Health Literacy. https://m-pohl.net/HLS19; 2025.
[34] About M-POHL | M-POHL - WHO Action Network on Measuring Population and Organizational Health Literacy. https://m-pohl.net/Aims; 2025.
[35] HLS19 International Report.pdf. https://m-pohl.net/sites/m-pohl.net/files/inline-files/HLS19%20International%20Report.pdf; 2025.
[36] Sørensen K, Van den Broucke S, Pelikan JM, Fullam J, Doyle G, Slonska Z, et al. Measuring health literacy in populations: illuminating the design and development process of the European health literacy survey questionnaire (HLS-EU-Q). BMC Public Health 2013;13:948.
[37] Zingg A, Siegrist M. Measuring people's knowledge about vaccination: developing a one-dimensional scale. Vaccine mai 2012;30(25):3771–7.
[38] Ruiz JB, Bell RA. Predictors of intention to vaccinate against COVID-19: results of a nationwide survey. Vaccine févr 2021;39(7):1080–6.
[39] Karlson KB, Holm A. Decomposing primary and secondary effects: A new decomposition method. Res Soc Stratif Mobil 2011;29(2):221–37.
[40] College Station TX. StataCorp LLC. StataCorp. Stata Statistical Software: Release 18. 2023.
[41] The HLS19 consortium of the WHO action network M-POHL. International report on the methodology, results, and recommendations of the European health literacy population survey 2019-2021 (HLS19) of M-POHL. In: International report on the methodology, results, and recommendations of the European health literacy population survey 2019–2021 (HLS19) of M-POHL. Vienna: Austrian National Public Health Institute; 2021 déc. https://m-pohl.net/sites/m-pohl.net/files/inline-files/Annex%20of%20the%20HLS19%20International%20Report_0.pdf.
[42] Sørensen K, Pelikan JM, Röthlin F, Ganahl K, Slonska Z, Doyle G, et al. Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). Eur J Public Health déc 2015;25(6):1053–8.
[43] Lorini C, Ierardi F, Bachini L, Donzellini M, Gemmi F, Bonaccorsi G. The antecedents and consequences of health literacy in an ecological perspective: results from an experimental analysis. Int J Environ Res Public Health avr 2018;15(4). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5923840/.
[44] Biasio LR, Zanobini P, Lorini C, Bonaccorsi G. Perspectives in the Development of Tools to Assess Vaccine Literacy. Vaccines 2024;12(4):422.
[45] de Figueiredo A, Simas C, Karafillakis E, Paterson P, Larson HJ. Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. Lancet 2020;396(10255):898–908.
[46] Kirbiš A. The impact of cultural capital on vaccine attitudes among the Slovenian public. Vaccines 2022;10(11):1947.
[47] Ligeti AS, Oroszi B, Luca C, Bilics E, Ágoston J, Röst G, et al. Socioeconomic determinants and reasons for non-acceptance to vaccination recommendations during the 3rd - 5th waves of the COVID-19 pandemic in Hungary. BMC Public Health 2024;24(1):1796.
[48] Shet A, Carr K, Danovaro-Holliday MC, Sodha SV, Prosperi C, Wunderlich J, et al. Impact of the SARS-CoV-2 pandemic on routine immunisation services: evidence of disruption and recovery from 170 countries and territories. Lancet Glob Health 2021;10(2):e186–94.
[49] World Health Organization. Varied impact of COVID-19 on routine immunization in the European Region. https://www.who.int/europe/news/item/16-07-2021-varied-impact-of-covid-19-on-routine-immunization-in-the-european-region; 2025.
[50] Sallam M. COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates. Vaccines 2021;9(2):160.
[51] Lazarus JV, Wyka K, White TM, Picchio CA, Rabin K, Ratzan SC, et al. Revisiting COVID-19 vaccine hesitancy around the world using data from 23 countries in 2021. Nat Commun 2022;13:3801.
[52] Shakeel CS, Mujeeb AA, Mirza MS, Chaudhry B, Khan SJ. Global COVID-19 vaccine acceptance: A systematic review of associated social and Behavioral factors. Vaccines 2022;10(1):110.
[53] Ratzan SC, Sommariva S, Rauh L. Enhancing global health communication during a crisis: lessons from the COVID-19 pandemic. Public Health Res Pract 2020;30(2):3022010.
[54] Marcell L, Dokania E, Navia I, Baxter C, Crary I, Rutz S, et al. One vax two lives: a social media campaign and research program to address COVID-19 vaccine hesitancy in pregnancy. Am J Obstet Gynecol 2022;227(5):685–695.e2.
[55] Toshkov D. Explaining the gender gap in COVID-19 vaccination attitudes. Eur J Pub Health 2023;33(3):490–5.
[56] de St. Maurice A, Schaffner W, Griffin MR, Halasa N, Grijalva CG. Persistent sex disparities in invasive pneumococcal diseases in the conjugate vaccine era. J Infect Dis 2016;214(5):792–7.
[57] Eckel CC, Grossman PJ. Chapter 113 Men, Women and Risk Aversion: Experimental Evidence. In: Plott CR, Smith VL, editors. Handbook of Experimental Economics Results. Elsevier; 2008. p. 1061–73. https://www.sciencedirect.com/science/article/pii/S1574072207001138.
[58] Singh P, Dhalaria P, Kashyap S, Soni GK, Nandi P, Ghosh S, et al. Strategies to overcome vaccine hesitancy: a systematic review. Syst Rev 2022;11:78.
[59] Zhang D, Zhou W, Poon PKM, Kwok KO, Chui TWS, Hung PHY, et al. Vaccine resistance and hesitancy among older adults who live alone or only with an older partner in Community in the Early Stage of the fifth wave of COVID-19 in Hong Kong. Vaccines 2022;10(7):1118.