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REVIEW

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Health literacy and vaccination: A systematic review

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ABSTRACT

This systematic review describes the current relationship between health literacy (HL) and vaccination (including attitude to vaccines, intention to vaccinate, and vaccine uptake). The aim is to comprehend the role of HL as a determinant of vaccine hesitancy. For this purpose, the following databases were explored from 1 January 2007 to 15 January 2017: *PubMed*, *Embase*, *PsycINFO*, *ERIC*, *Health Evidence*, *Centre for Reviews and Dissemination*, *Scopus*, *Web of Science*, and *Cochrane Library*. Nine studies were included in the final synthesis. The role of HL in predicting vaccine hesitancy or acceptance seems to be influenced by a few key factors. These include country, age, and type of vaccine. However, the relationship between HL and vaccination remains unclear. New research studies are needed—particularly longitudinal ones that use multiple measurement tools. This would facilitate a better understanding of the role of HL in predicting vaccine uptake.

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KEYWORDS

compliance; health literacy; prevention; vaccination; vaccine hesitancy

Introduction

Vaccines have proved their ability to prevent illness, disability, and death from vaccine-preventable diseases. Vaccines today provide protection from even certain types of cancer. Indeed, there is a wide range of evidence supporting vaccination and immunization. Yet, people continue to challenge the evidence and refuse vaccinations in many parts of the world.¹

Global vaccination coverage has remained steady in the past few years. Vaccination coverage varies with different vaccines. In 2015, for example, 86% of infants worldwide received three doses of the diphtheria–tetanus–pertussis vaccine and three doses of the polio vaccine; 64% of infants were administered three doses of the *Haemophilus influenzae* Type B vaccine; and only 37% and 23% of infants received the pneumococcal and rotavirus vaccines respectively.² Vaccine hesitancy is the refusal of people to take vaccines or a delay in vaccine acceptance despite vaccination offers from health authorities. This behavioural phenomenon is context- and vaccine-specific. It results from a complex decision-making process that is influenced by many factors. These factors can be summarized into three categories: complacency, convenience, and confidence.³



Health literacy (HL) is a multifaceted concept that deals with the capacities of people to meet the complex demands of health in a modern society.⁴ The Sørensen Integrated Model states: ‘health literacy is linked to literacy and entails people’s knowledge, motivation, and competence to access,

understand, appraise, and apply health information in order to make judgments and take decisions in everyday life concerning healthcare, disease prevention, and health promotion to maintain or improve quality of life during the life course’.⁵

HL is independently associated with several undesirable health outcomes, including poorer overall health status,^{6,7} hospitalization,^{8,9} mortality,¹⁰ and healthcare costs.¹¹ HL also influences people’s ability to engage in preventive activities like cancer screening.¹² Hence, the improvement of HL is crucial to develop a new type of relationship between individuals and the healthcare system.¹³

A recent review has looked at existing evidence on the interaction between HL and infections, including within its purview preventive behaviours like vaccinations. The review suggests that the influence of HL on the clinical and social outcomes of infectious diseases needs further exploration.¹⁴

The concept of ‘vaccine literacy’ looks at HL from the point of view of vaccine attitudes and hesitancy in order to better define and understand the main determinants of vaccine uptake. Specifically, ‘vaccine literacy is not simply knowledge about vaccines, but also developing a system with decreased complexity to communicate and offer vaccines as *sine qua non* of a functioning health system’.¹ The information about vaccines tends to be complex. Comprehending this information requires certain literacy and numeracy skills, which is why communicating the information to patients is a challenge,

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particularly if the patients have low HL.¹⁵ Moreover, critical¹ and evaluation² skills are required to seek out the right information, especially considering the ever-increasing information glut in the media, particularly on the Internet.^{16,17} In such a scenario, HL, and specifically vaccine literacy, can influence vaccine uptake. Hence, they should be considered as potential determinants of vaccine hesitancy.¹⁸

This review aims to describe the state of the art in the relationship between HL and the attitude towards vaccines, intention to vaccinate, and vaccine uptake. The goal is to examine the role of health literacy or illiteracy as a determinant of vaccination hesitancy.

Materials and methods

A literature search was conducted to identify primary studies that address the relationship between HL and vaccination.

The following databases were explored for this purpose: *PubMed*, *Embase*, *PsycINFO*, *ERIC*, *Health Evidence*, *Centre for Reviews and Dissemination*, *Scopus*, *Web of Science*, and *Cochrane Library*.

We considered only primary studies that investigate the link between HL and behaviour towards vaccination—whether vaccination awareness and knowledge, compliance with recommended child vaccinations, or immunization status. Our research investigated all kinds of vaccines.

We included studies on persons of all ages whose HL had been measured using a tool that investigated one or more HL areas, such as basic or functional literacy, communicative or interactive literacy, and critical literacy, as described by Nutbeam.¹⁶ For the purpose of this literature review, we looked at articles published from 1 January 2007 to 15 January 2017 without any language limits.

PubMed

In order to reach maximum sensitivity, since the field of interest is recent, a general search query was built as follows:

```
(((health literacy [MeSH Terms]) AND vaccin*)) OR
(((vaccin* AND literacy) OR (vaccin* AND hesit*) OR
(vaccin* AND refus*))) AND ("2007"[Date
Publication] : "2017 / 01 / 15"
[Date Publication])
```

Eric, Cochrane Library, Health Evidence, Embase, PsycINFO, Scopus, Web of Science

For *PubMed*, a general query was used. Wherever possible, the search was limited to primary studies and publication periods using Boolean operators.

Search strategy: (health literacy AND vaccine) OR (health literacy AND vaccination)

After each search, we removed the duplicates derived from different databases. The next step was selecting the papers that matched the query according to their titles. Following this, the relevant manuscripts were selected based on their abstracts. Among the discarded papers (dealing with the definition and spreading of vaccine hesitancy or refusal in general, or the tools used to measure or challenge these attitudes), we performed a secondary screening to improve the specificity of the search. Full texts were searched using the terms 'literacy' or 'education', and contexts were analysed to find research papers that fit our query.

Finally, among the remaining papers, we extracted only those in which full texts dealt with the topic of interest. We checked the references of each chosen work to identify other suitable studies.

Two authors conducted the selection process independently. At the end of the selection, any disagreements about the inclusion/exclusion process were resolved in a consensus meeting; a third reviewer was consulted in the event of continued disagreement.

The methodological quality of all the included studies was assessed using the quality rating list applied by Tooth et al.¹⁹ This checklist consists of 33 items that are used to evaluate the quality of reporting of observational studies. The criteria reflect design and interpretation aspects covering the study rationale and population, recruitment, measurement and biases, data analysis, and generalizability of results. The criteria represent two main categories: (1) aspects that could influence effect estimates and (2) aspects related to more descriptive or contextual elements. Depending on the design of the studies, not all criteria were deemed applicable to all studies.

As for the selection process, two authors independently appraised the methodological quality of all the included studies. Any disagreements on quality ratings between the two reviewers were resolved in the course of a consensus meeting; a third reviewer was consulted in the event of a disparity. If applicable, each criterion was assessed with a 'yes' (= 1) or a 'no' (= 0), giving equal weight to the different criteria. A total quality score, generated by summing up the score obtained in each item, was assigned to each study. A study was considered to have a high quality of reporting if the total score was higher than 60% of the obtainable positive ratings, taking into account the applicable items.

Results

Figure 1 shows the steps of the search and selection process. We identified more than 1,000 relevant research papers through our search strategy. However, only nine studies proved satisfactory for the purpose of this review. Table 1 summarizes our findings by providing information on each of the nine studies.

All the studies were observational ones. They were primarily based on cross-sectional designs, though one was a longitudinal-prospective cohort study.

The types of evaluated vaccinations varied according to the investigated age ranges. Influenza, human papillomavirus (HPV), and pneumococcal vaccines were considered for studies

¹The term 'critical HL' refers to cognitive skills that can be applied to critically analyse information and use it to exert greater control over life events and situations.

²The term 'evaluation skills' refers to the ability to filter, interpret, and evaluate information.

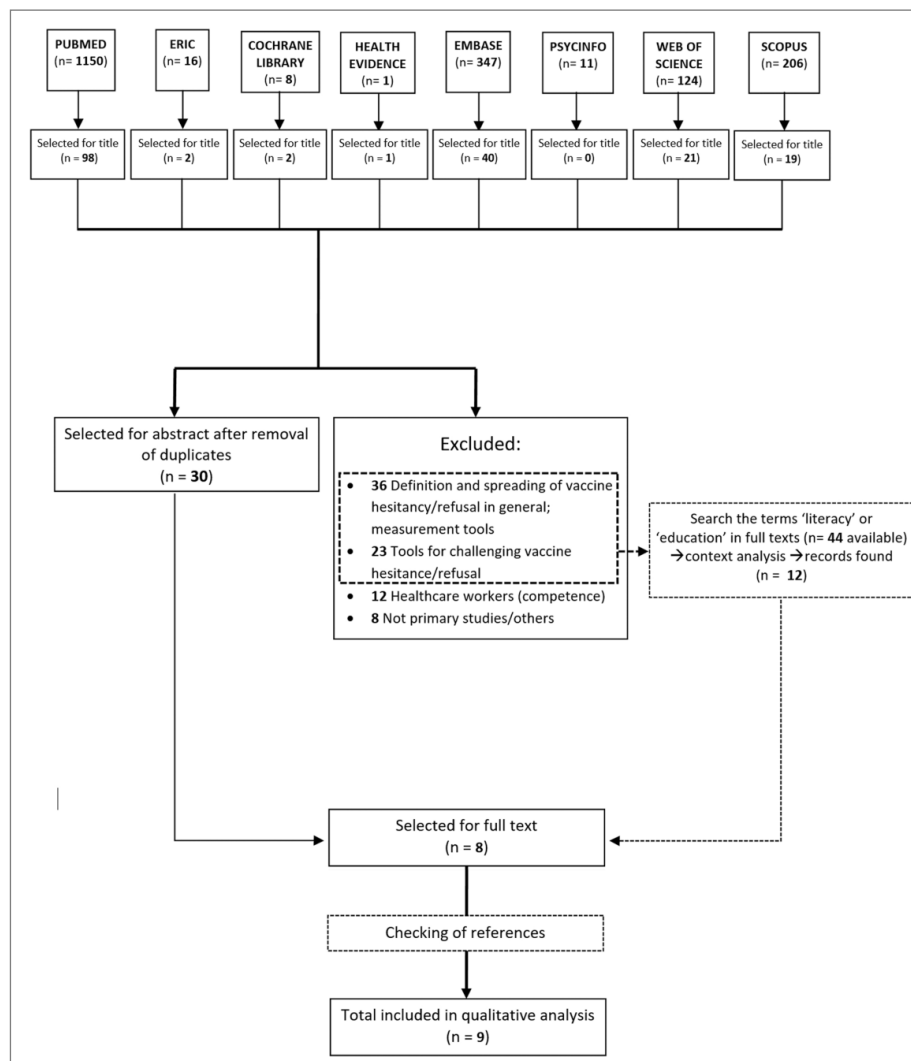


Figure 1. Flow diagram of study selection.

devoted to the adult population. To study the immunization status of children, vaccinations administered within 24 months of age were investigated. These included Hepatitis B, diphtheria–tetanus–pertussis, mumps, measles, rubella, polio, *Haemophilus influenzae* Type B, pneumococcal, and rotavirus vaccinations. In four studies, the study sample was represented by the parents of children who received childhood vaccinations. Adult citizens in the USA were the focus of two studies. One study looked at women of college-going age, another considered adult Hispanic females in the USA, and a third focused on adults aged 65 years or above in the USA.

The approach for measuring HL varied among different studies. Six studies^{12,20–24} focused on the validated instruments used to measure HL. These included the National Assessment of Adult Literacy (NAAL) health literacy scale, the Short Form Test of Functional Health Literacy in Adults (S-TOFHLA), the Newest Vital Sign (NVS), and Chew's Set of Brief Screening Questions (SBSQ). Some HL-specific questionnaires were also adapted to measure the HL of the study population in three cases.^{25–27} These instruments primarily investigated functional HL, which relates to communication and information. Functional HL refers to the capability to transmit real information

on vaccinations without including interactive³ and critical HL. Thus, these instruments do not measure all the multifaceted components of HL. In one case, an HL tool also evaluated communicative (development of personal skills) and critical (personal and community empowerment) HL. In doing so, it provided a more comprehensive measure of HL.

The studies mainly investigated whether HL influences attitudes towards vaccinations. Attention was paid particularly to the compliance of parents with the recommended childhood vaccinations. Considering the increasing vaccine hesitancy among parents, there were indications of parents complying with only some of the vaccinations in the recommended protocol, delaying immunization due at a certain age, or even refusing all vaccinations. Adult immunization status was also the subject of study in the context of the adherence to preventive health behaviours. One study evaluated HL in a bid to

³The term 'interactive HL' refers to more advanced cognitive and literacy skills that, together with social skills, can be used to actively participate in everyday situations, extract information and derive meaning from different forms of communication, and apply this to changing circumstances.⁵

Table 1. Summary of each included study.

Author, Year	Study Design	Scope of Study	Study Sample	HL Areas Investigated, HL Measurement Tools	Vaccinations Investigated	HL and Vaccination: Results
Aharon et al., 2017 ²⁵	Cross-sectional study	To investigate the relationship between the HL of parents and their compliance with the recommended child vaccinations	731 parents of children aged between three and four years Two groups identified: Children who did not complete at least one of the three childhood vaccinations Control group of children who completed the three vaccinations (Country: Israel)	Functional, communicative, and critical HL were evaluated using the Vaccine Health Literacy Scale, a questionnaire with 13 items adapted from the HL Questionnaire developed by Ishikawa, Takeuchi, and Yano	Hepatitis B, diphtheria-tetanus-pertussis, mumps, measles, and rubella. These are routinely administered during the first year of life and represent the core vaccination protocol	Communicative HL has a significant negative direct association with vaccination compliance; parents with highly functional, communicative, and critical HL are more at risk of not vaccinating their children (through significant negative indirect association)
Bennett et al., 2009 ²⁰	Cross-sectional study	To assess whether HL contributes to racial/ethnic and education-related disparities in preventive health behaviours (including influenza vaccinations) among older adults	2,668 adults aged 65 years and above (Country: USA)	Functional HL was evaluated using the HL scale of the NAAL, which comprised health-related tasks (12 prose items, 12 documents, and four quantitative items)	Influenza vaccination	Increased HL is associated with the likelihood that an older adult would have received the influenza vaccination Health-related print literacy significantly mediated the racial/ethnic disparity in self-rated health status and the receiving of the influenza vaccination
Johri et al., 2015 ²⁶	Cross-sectional study	To investigate whether maternal HL is associated with children receiving vaccines in two Indian communities	Mothers of children aged 12–23 months, living in urban or rural sites (1,170 women from 60 villages and 670 women from nine slums (Country: India)	Functional HL was evaluated using an HL tool developed from Indian child health promotion materials, consisting of questions related to three images	Diphtheria-tetanus-pertussis vaccination (three doses) (DTP3)	Maternal HL is independently associated with child vaccination; there is a positive association between maternal HL and DTP3
Lee et al., 2015 ²⁷	Cross-sectional study (secondary data analysis from two surveys)	To investigate predictors of the HPV vaccination in young Asian, American, and Pacific Islander (AAPI) and non-Latina white (NLW) women	This study was conducted at a public university in the Midwest (USA) and involved 2,270 women of college-going age (18–25 years): 341 AAPI and 1,929 NLW (Country: USA)	HPV vaccine literacy was ascertained based on the number of correct answers to a questionnaire with five items; the questions were adopted from the vaccination guidelines created by the National Cancer Institute	HPV vaccination	In both groups of undergraduate women, HPV vaccine literacy was a significant predictor related to completion of the HPV vaccination
Moran et al., 2017 ²¹	Cross-sectional study	To investigate the predictors of influenza vaccination among Hispanic female subgroups in the USA	1,565 Hispanic females aged 21–50 years (Country: USA)	Functional HL was investigated using Chew's SBSQ	Influenza vaccination	Vaccine safety confidence varied according to the HL. Those with higher HL were more confident about vaccine safety The frequency of influenza vaccination did not vary significantly in accordance with HL. But confidence in vaccine safety was associated with a greater likelihood of regular influenza vaccination
Pati et al., 2011 ²²	Longitudinal prospective cohort study	To investigate the association between maternal HL and early immunization status	506 mother-infant dyads (Country: USA)	Functional HL was investigated S-TOFHLA	Hepatitis B, polio, <i>Haemophilus influenzae</i> Type B, pneumococcal, diphtheria-tetanus-pertussis vaccinations	Maternal HL was not significantly associated with immunization status at either three or seven months

(continued on next page)



Table 1. (Continued)

Author, Year	Study Design	Scope of Study	Study Sample	HL Areas Investigated, HL Measurement Tools	Vaccinations Investigated	HL and Vaccination: Results
Smith et al., 2015 ²³	Cross-sectional study (single-mode mail survey)	To investigate the association between HL and HPV awareness and knowledge	3,165 adult respondents to the survey (Country: USA)	Functional HL was evaluated using NVS	HPV vaccination	Significant associations between HL and awareness of HPV, and correct knowledge that HPV can cause cervical cancer
Veldwijk et al., 2015 ²⁴	Cross-sectional study	To evaluate if HL is associated with parental preferences concerning childhood vaccinations	467 Dutch parents of newborns aged six weeks	Functional HL was investigated using Chew's SBSQ (a subjective measure of HL containing three items)	Rotavirus vaccination	HL is associated with parental preferences for rotavirus vaccination Respondents with lower HL considered the duration of protection to be more important, and vaccine effectiveness and frequency of severe side effects to be less important, as compared to respondents with higher HL and education
White et al., 2008 ¹²	Cross-sectional study	To identify the relationship between HL and self-reported preventive health practices (including influenza and pneumococcal vaccination) of adults in the USA	18,000 representative adults (aged 16 years and above) (Country: USA)	Functional HL was evaluated using the NAAL health literacy scale (with 28 health-related items)	Influenza and pneumococcal vaccination (the latter only for adults aged 65 years or above)	For adults aged 65 years and above, a significant positive association was found between HL and influenza vaccination; meanwhile, HL was not positively associated with pneumococcal vaccination For adults younger than 40 years, a negative relationship was found between HL and the influenza vaccination

define its association with awareness and knowledge about the HPV vaccination.

Different outcomes were noted. Considering the association between HL and the attitudes of parents towards vaccinations, a study revealed that communicative HL had a significant negative direct association with vaccination compliance. The study found functional HL and critical HL to have an indirect effect, mediated through other variables, on completion of the vaccination protocol. This suggests that parents with highly functional, communicative, and critical HL are more at risk of not vaccinating their children.²⁵ Another study investigated the association between HL and the preferences of parents regarding the rotavirus vaccination. Parents with lower HL demonstrated more interest in the duration of vaccine protection. They seemed less concerned about the effectiveness of the vaccine and the frequency of severe side effects.²⁴

Maternal HL and the immunization status of children were not significantly associated, said a study on mother–infant dyads in the USA.²² In contrast, a study conducted in India suggested that maternal HL was independently associated with child vaccination. This study revealed a positive association between maternal HL and the diphtheria–tetanus–pertussis vaccination for children.²⁶

Adult HL has shown positive associations with the receiving of the influenza vaccination in the elderly.¹² Research conducted on women of college-going age found positive associations with the completion of HPV vaccinations, and with HPV awareness and knowledge.²⁷

At the same time, HL did not have positive associations with the pneumococcal vaccination in older adults. A negative relationship between HL and the influenza vaccination was also demonstrated for adults younger than 40 years.¹²

The compliance with the influenza vaccination did not vary significantly in accordance with HL among adult Hispanic females in the USA. However, HL was proved to influence vaccine safety confidence. A higher level of vaccine safety confidence was associated with a greater likelihood of regular influenza vaccination.²¹

Table 2 presents the methodological quality assessment scores of the nine selected articles. The scoring of the publications led to an initial overall disagreement of 23% between the reviewers. The disagreements mostly related to items 25, 30, 31, and 32 (absolute effect; impact of biases; results relating back to the target population), and generally resulted from incomplete descriptions or errors of interpretation. All the initial disagreements were resolved in the course of a consensus meeting. According to the total score, six studies (66.7%) have been classified as high-quality reporting (score > 60%).^{12,20–22,24,26}

For the cross-sectional studies, the scores ranged from 7/28 (25%) to 20/28 (71.4%); meanwhile, the cohort study reported a score of 24/32 (72.7%).²² The study of Smith et al. obtained the lowest score. This was presumably due to the type of article (a letter to the editor). In this case, the editorial criteria required a shorter length, which resulted in a much less in-depth description of the study.²³

All nine studies provided information about their objectives and the types of analyses conducted. They also reported the relative effect sizes (ratio of rates, proportions, or other measures

of effect). Not one study explained why people refused consent to the vaccination. Furthermore, none of the studies reported the absolute effect sizes—that is, the outcome of an exposure expressed, for example, as the difference between rates, proportions, or means, as opposed to the ratios of these measures. Only one paper mentions the issues of ‘selection in’—that is, any aspect of recruitment or setting that results in the selective choice of participants.²⁴ And one paper compares consenters with non-consenters.²²

Discussion

Only nine papers met the inclusion criteria for this review. So far, the relationship between HL and vaccination has been investigated only to a limited extent. The studies that focus on the topic are all fairly recent. Moreover, the geographical distribution is skewed: most (six) of these studies (66.7%) have been conducted in the USA. This suggests that researchers in the USA have been studying this topic with greater interest over time. Furthermore, only the research conducted by Johri and colleagues was performed in a low-income country.²⁶ Three studies were conducted in two high-income countries that were included in the WHO European Region (The Netherlands and Israel, respectively).^{24,25} Thus, the geographical representativeness of the studies conducted so far is poor. This limits the generalizability of the findings and comprehension of the phenomenon.

According to the ‘3C’ model, confidence, complacency, and convenience influence vaccine hesitancy. Specific determinants of vaccine hesitancy can be grouped in three categories: contextual, individual, and group vaccination.^{28,29} In such a model, HL may influence contextual as well as individual or group determinants. Hence, vaccination uptake also depends on the political and socio-cultural contexts in which the studies were performed.³⁰

Eight of the nine manuscripts described results obtained through a cross-sectional approach.

Hence, it is possible to argue about associations but not about causations.^{31,32}

The nine studies considered here included different target populations. They also investigated behaviours related to many different vaccinations based on age and the vaccination schedule of various countries. The statistical analyses also differ according to the aim of each study. So, HL is sometimes considered to be a potential co-factor in predicting outcomes; in other cases, HL acts as a mediator. The results described are different too. In the longitudinal study,²² maternal HL had no significant association with the immunization status of children, while in the other eight studies, all possible relationships (positive association, negative association, no association, both as direct effect and as mediators) were found.

To summarize, three categories of the target population can be defined: elderly people, adults, and parents of young children. White et al.¹² investigated influenza and pneumococcal vaccinations with a focus on the elderly. Bennett et al.²⁰ looked at elderly participants too, but considered only the influenza vaccination. Both studies found a significant positive relationship between HL and influenza vaccination uptake but no

Table 2. Results of methodological quality assessment of all included studies.

ITEM (description) ¹⁹	Aharon, 2017 ²⁵	Bennett, 2009 ²⁰	Johri, 2015 ²⁶	Lee, 2015 ²⁷	Moran, 2017 ²¹	Pati, 2011 ²²	Smith, 2015 ²³	Veldwijk, 2015 ²⁴	White, 2008 ¹²	%
1. Are the objectives or hypotheses of the study stated? (Self-explanatory)	1	1	1	1	1	1	1	1	1	100.0
2. Is the target population defined? (The group of persons toward whom inferences are directed. Sometimes the population from which a study group is drawn)	1	1	1	1	1	1	0	1	1	88.9
3. Is the sampling frame defined? (The list of units from which the study population will be drawn)	0	1	1	1	1	1	0	1	1	77.8
4. Is the study population defined? (The group selected for investigation)	1	1	1	1	1	1	0	1	1	88.9
5. Are the study settings (venues) and/or geographic locations stated? (Comment required about location of research. Could include name of center, town, or district)	1	1	1	1	1	1	0	1	1	88.9
6. Are the dates during which the study was conducted stated or implicit? (Self-explanatory)	1	1	1	1	1	1	0	0	1	77.8
7. Are the eligibility criteria stated? (The words "eligibility criteria" or equivalent are needed, unless the entire population is the study population)	1	1	1	1	1	1	0	1	1	88.9
8. Are the issues of 'selection in' to the study mentioned? (Any aspect of recruitment or setting that results in the selective choice of participants)	0	0	0	0	0	0	0	1	0	11.1
9. Is the number of participants justified? (Justification of number of subjects needed to detect anticipated effects. Evidence that power calculations were considered and/or conducted.)	0	1	0	0	0	1	0	0	1	33.3
10. Are numbers of participants meeting and not meeting the eligibility criteria stated? (Quantitative statement of numbers)	0	0	0	0	1	1	0	0	0	22.2
11. For those not eligible, are the reasons why stated? (Broad mention of the major reasons)	0	0	0	0	0	1	0	0	0	11.1
12. Is the number of people who did/did not consent to participate stated? (Quantitative statement of numbers)	0	0	0	0	0	1	0	1	0	22.2
13. Are the reasons people refused to consent stated? (Broad mention of the major reasons)	0	0	0	0	0	0	0	0	0	0
14. Were consenters compared with non-consenters? (Quantitative comparison of the different groups)	0	0	0	0	0	1	0	0	0	11.1
15. Was the number of participants at the beginning of the study stated? (Total number of participants -after screening for eligibility and consent- included in the first stage of data collection)	1	1	1	1	1	1	0	1	0	77.8
16. Were methods of data collection stated? (Descriptions of tools)	1	1	1	1	1	1	0	1	1	88.9
17. Was the reliability (repeatability) of measurement methods mentioned? (Evidence of reproducibility of the tools used)	0	1	0	0	0	1	0	1	1	44.4
18. Was the validity (against a 'gold standard') of methods of measurement mentioned? (Evidence that the validity was examined against, or discussed in relation to, a gold standard)	0	1	0	0	0	1	0	1	1	44.4
19. Were any confounders mentioned? (Confounders were defined as a variable that can cause or prevent the outcome of interest, is not an intermediate variable, and is associated with the factors under investigation)	1	1	1	1	1	1	0	1	1	88.9
20. Was the number of participants at each stage/wave specified? (Quantitative statement of numbers at each follow-up point)	NA	NA	NA	NA	NA	1	NA	NA	NA	100.0
21. Were reasons for lack of follow-up quantified? (Broad mention and quantification of the major reasons)	NA	NA	NA	NA	NA	0	NA	NA	NA	0
22. Was the number of missing data items at each wave mentioned? (Differences in numbers of data points -indicating missing data items- explained)	NA	NA	NA	NA	NA	1	NA	NA	NA	100.0
23. Were the types of analyses conducted stated? (Specific statistical methods mentioned by name)	1	1	1	1	1	1	1	1	1	100.0
24. Were 'longitudinal' analysis methods stated? (Longitudinal analyses were defined as those assessing change in outcome over two or more time points and that take into account the fact that the observations are likely to be correlated)	NA	NA	NA	NA	NA	1	NA	NA	NA	100.0

(continued on next page)

Table 2. (Continued)

ITEM (description) ¹⁹	Aharon, 2017 ²⁵	Bennett, 2009 ²⁰	Johri, 2015 ²⁶	Lee, 2015 ²⁷	Moran, 2017 ²¹	Pati, 2011 ²²	Smith, 2015 ²³	Veldwijk, 2015 ²⁴	White, 2008 ¹²	%
25. Were absolute effect sizes reported? (<i>Absolute effect was defined as the outcome of an exposure expressed, for example, as the difference between rates, proportions, or means, as opposed to the ratios of these measures</i>)	0	0	0	0	0	0	0	0	0	0
26. Were relative effect sizes reported? (<i>Relative effects were defined as a ratio of rates, proportions, or other measures of an effect</i>)	1	1	1	1	1	1	1	1	1	100.0
27. Was lack of follow-up taken into account in the analyses?* (<i>Specific mention of adjusting for, or stratifying by, loss to follow-up</i>)	NA	NA	NA	NA	NA	0	NA	NA	NA	0
28. Were confounders accounted for in the analyses? (<i>Specific mention of adjusting for, or stratifying by, confounders</i>)	1	1	1	1	1	0	1	1	1	88.9
29. Were missing data accounted for in the analyses? (<i>Specific mention of adjusting for, or stratifying by, or imputation of missing data items</i>)	0	0	0	0	1	0	0	0	1	22.2
30. Was the impact of biases assessed qualitatively? (<i>Specific mention of bias affecting results, but magnitude not quantified</i>)	1	1	1	1	1	0	1	1	1	88.9
31. Was the impact of biases estimated quantitatively? (<i>Specific mention of numerical magnitude of bias</i>)	1	1	1	0	0	0	1	0	1	55.6
32. Did authors relate the results back to a target population? (<i>A study is generalizable if it can produce unbiased inferences regarding a target population -beyond the subjects in the study</i>)	1	1	1	0	0	1	1	1	1	77.8
33. Was there any other discussion of generalizability? (<i>Discussion of generalizability beyond the target population</i>)	1	0	1	1	1	1	0	1	1	77.8
Not applicable items	28	28	28	28	28	33	28	28	28	
Total score, N (%)	16 (57.1)	19 (67.9)	17 (60.7)	15 (53.6)	17 (60.7)	24 (72.7)	7 (25.0)	19 (67.9)	20 (71.4)	

*not for cross-sectional.

The term 'critical HL' refers to cognitive skills that can be applied to critically analyse information and use it to exert greater control over life events and situations.

The term 'evaluation skills' refers to the ability to filter, interpret, and evaluate information.

The term 'interactive HL' refers to more advanced cognitive and literacy skills that, together with social skills, can be used to actively participate in everyday situations, extract information and derive meaning from different forms of communication, and apply this to changing circumstances.⁵

significant association between HL and the pneumococcal vaccination. The studies of White et al.¹² and Moran et al.²¹ found no significant association between HL and the influenza vaccination in adult subgroups (40–64 years for White et al. and 21–50 years for Moran et al.). However, White et al. did find a significant negative relationship in the young adult subgroup (16–39 years). The attitude towards vaccination among young adults was also investigated by Lee et al.²⁷ and Smith et al.²³ The two studies showed a significant positive association between HL and the HPV vaccination, as well as between HL and vaccination knowledge and awareness. Finally, in four studies,^{22,24–26} the HL of parents and the vaccinations of their daughters or sons were investigated. However, the study outcomes varied considerably. The study from India noted a significant positive relationship between the HL of parents and vaccinations for their children. No such association was found in the longitudinal study conducted in the USA. Yet, two studies—one conducted in Israel and the other in The Netherlands—found a significant negative relationship between the two.

Hence, the role of HL in predicting vaccine uptake appears to be age- and vaccine-specific. The relationship between HL and vaccinations seems to be driven by risk perceptions and by the likelihood of getting sick or suffering from complications in the short term. When these possibilities are high, HL positively predicts vaccination uptake; when they are low, HL negatively predicts vaccination uptake or shows no effect. This aspect is particularly relevant in the

context of parents. For them, the balance between the perceived benefits and the perceived barriers is driven by a sense of responsibility towards their child. This highlights the multifaceted nature of their choices regarding vaccinations.^{33,34}

Six papers investigated the relationship between HL and vaccinations using different standardized measurement tools (NAAL, S-TOFHFLA, NVS, and Chew's SBSQ).^{12,20–24} Two of the tools (NAAL and Chew's SBSQ) are self-reported HL measures while the other two (S-TOFHFLA and NVS) are performance-based HL and numeracy measures. Moreover, they strongly differ in the number of items they include (ranging from 36 items to only three). None of the studies reported multiple HL measures, although McCormack et al.³⁵ suggested including multiple tools in the study design for more in-depth measurements of HL. In fact, Kiechle et al.³⁶ concluded in a recent review that there is a paucity of studies on the differences in the relationships between performance-based and self-reported measures of HL and health outcomes. So, there is no way of knowing if the use of different tools will lead to the same results. This could explain why different relationships were found between HL and vaccinations in six studies.^{12,20–24}

Three studies^{25–27} used ad hoc measurement tools specifically developed for vaccine literacy. Many authors encourage the development of new tools to address more sub-domains of HL.^{35,37} Unfortunately, they do not describe the psychometric properties of the tools (with the exception of Cronbach's alpha).

They also do not offer references to validation studies dealing with measures that have already been validated. A more in-depth investigation of the differences between vaccine literacy and HL is necessary. For this reason, new studies focused on the validity of specific measures of vaccine literacy and on the comparison of different measures of HL are encouraged.

The results of this review give rise to a complicated picture that is influenced by many social determinants. It seems difficult to draw a universal conclusion. This complicates the task of suggesting public health interventions that could both increase the compliance with voluntary immunization and contain vaccine hesitancy. Besides, it is necessary to keep in mind the World Health Organization's (WHO) lesson through the Ottawa Chart and the subsequent policies that were suggested. HL is important in the areas of healthcare, disease prevention, and health promotion; it is defined as the process of enabling people to increase control over and improve their health (Ottawa Chart, WHO, 1986). Thus, the goal should be to increase HL among individuals and in the overall population. It is also essential to control the effects of higher HL by evaluating people's empowerment with regard to requesting, seeking, and/or refusing health services such as vaccinations. In fact, an individual refusal can have dramatic consequences for public health when it undermines protection and herd immunity.

There are already well-documented episodes in which HL and vaccination have not had a positive relationship. During 2014–2015 flu season, the 'FLUAD case' in Italy underlined the potential problems. It showed how panic and an excess of (incorrect) information can generate a disaster in the area of flu protection due to low vaccination rate, independently from the level of individual and 'distributed' literacy. The refusal to take the flu vaccine was independent from the citizens' level of education and health knowledge. Rather, it resulted from an enormous misunderstanding that was mainly provoked by the wrong communication given after withdrawal of the flu vaccine. The disproportionate media coverage given to the Agenzia Italiana del Farmaco (AIFA, the Italian medicine agency) decision led to reduced vaccine confidence in the general population. In turn, it resulted in decreased immunization coverage, which persisted in subsequent seasons. This led to an excess of mortality, especially among the elderly.^{38,39}

In this case, the concept of 'distributed' HL⁴⁰ did not work. The great majority of unvaccinated people were elderly—that is, persons whose health decisions were often taken by family members or their family physicians, or by both groups in consultation. There was a need to confirm the scarce level of distributed HL even on the part of health professionals. This did not counterbalance the bias of the extensive media coverage of the event. An increase in fatal events was reported to have occurred within the first few days after vaccination, even if most of those deaths were clearly linked to the extremely precarious medical conditions of the patients. The media amplified the news of deaths potentially related to vaccine shots and no counterpart provided the correct messages to the public. The result was a fall of 7% in flu vaccinations among elderly people between the 2013–14 and 2014–15 seasons (55.4% against 48.6%).^{41,42}

Sharing decisions and solutions is a specific aspect of the interactive dimension of HL.

In early 2017, a measles epidemic began in Italy, accounting for about 26% of all cases at the European level.^{43,44} The cause of this epidemic lies in the lack of a vaccine coverage threshold. This threshold has never been reached since the implementation of the National Plan for the elimination of measles and congenital rubella.⁴⁵ HL could be a key to recover people's confidence in the measles vaccination. But the public health authorities must start by giving people the right information together with practical solutions. In this case, the interactive dimension of HL, with the support of a health literate health-care organization,⁴⁶ could help increase immunization levels and contain the risk of new epidemics.

To create conditions of better health for all, and consequently promote health interventions like vaccinations, people should receive support for their decisions. Community action should be reinforced to create empowerment and health services should be reoriented to bring them closer to citizens. Vaccine hesitancy is a defeat of people's empowerment; hence, it must be fought in every possible way and the improvement of HL is essential for it. Specific information and training interventions are needed at various levels. These should aim at increasing awareness on vaccine-preventable infectious diseases and vaccinations.⁴⁷

In conclusion, the relationship between HL and vaccinations remains unclear. The reasons for this lie in the paucity of published studies, and the differences in the researches conducted so far with regard to the tools used to assess HL, the target populations, and the outcome measures. There is a need to implement new studies using multiple measurement tools—that is, tools that are specific to vaccine literacy and those used to measure general HL. This would ensure a more comprehensive assessment of HL, thus leading to a better understanding of the role played by HL in predicting vaccine uptake or moderating the effect of other determinants of vaccination behaviours. Longitudinal studies should be encouraged in order to test hypotheses for causation.

The role of HL in predicting vaccine hesitancy or acceptance seems to be influenced by various factors (including country, age, and type of vaccine). Therefore, it may not be possible to suggest a public health intervention aimed at increasing vaccine literacy as a universal and generic solution for the general population.

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No potential conflicts of interest were disclosed.

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