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Assessing COVID-19 vaccine literacy: a preliminary online survey

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ABSTRACT

The COVID-19 infodemic can be countered by scientific evidence, clear and consistent communication, and improved health literacy of both individuals in need of information and those providing it. A rapid online survey was carried out to evaluate vaccine literacy (VL) skills in the general population and perceptions about COVID-19 vaccine candidates, along with behavior and beliefs about current vaccinations. Observed VL levels were consistent with previous observations – where comparable self-reported tools were administered face-to-face and by paper-and-pencil – the mean functional score being = 2.92, while the interactive-critical score was = 3.27, out of a maximum of 4. Perceptions regarding future COVID-19 vaccines, along with beliefs about vaccination, were mostly positive and significantly associated with functional and interactive-critical VL scales. Despite limitations, the study confirms that surveys via the web are a suitable method to evaluate and track attitudes during infectious disease outbreaks and assess health literacy skills about vaccination, which can be useful to adapt medical communication strategies, for a better understanding of the value of immunization.

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Vaccine Literacy; Vaccination Beliefs; COVID-19; Online Surveys

Introduction

The COVID-19 pandemic had a dramatic health, social, and economic impact. As of the time of this report, the level of uncertainty was extremely high and exacerbated by an excess of contradictory information. Many lay media and websites have unceasingly delivered real-time numbers on new cases and deaths, often also providing unauthorized medical advices, without waiting for confirmation. The amount and variety of news have led to a massive informative overload, generating a real infodemic.[1,2]

Providing the population with evidence-based scientific data is beneficial and necessary, but does not necessarily lead to individuals correctly understanding or interpreting the information. Evidence-based data runs the risk of being self-defeating if too much information is released and the public become saturated with different facts and contradictory information, leading to emotional reactions and mistrust toward decision-makers.[3] Moreover, debates among individuals and organizations who have a strong web and media presence, often provoke conflicting opinions and negative beliefs, as in the current COVID-19 situation.

One of the most commonly discussed topics is about prevention of SARS-CoV-2 through the development of vaccines: there is a lot of information from different sources, often conflicting, that have already caused much controversy and, in some cases, been labeled as "fake news."

The aim of the current survey was to assess people's abilities to collect and understand information about vaccinations, at a time when discussion was particularly intense about the future COVID-19 vaccines, during the early stage of their development (June 2020). These abilities correspond to health literacy skills, entailing people's knowledge, motivation and competence to find, understand and use health information,[4] which is critical amidst a pandemic.[5]

Methods

The primary objective of this cross-sectional study was to evaluate the feasibility of assessing the levels of health literacy skills about vaccination (vaccine literacy – VL) in the Italian adult general population, through a rapid survey administered via the web. Supplementary objectives were to collect perceptions of the interviewees about candidate COVID-19 vaccines, their behavior about current adult immunization and beliefs about vaccination in general, as well as evaluating correlation of these variables with VL levels.

We used an anonymous online survey, which respondents could choose to complete or not. The questionnaire was prepared, distributed, and collected by 'SurveyMonkey,' an online service that creates web-based surveys, that can be inserted into e-mail messages and web pages, and shared through other online services. A web link collector generated the survey URL through which respondents could access the survey and send their answers. For its distribution, a convenient, non-probability sampling method was adopted. The URL was sent via e-mail messages on June 5, 2020 (a reminder was sent on June 13) to about 50 addressees selected from the mailing list of Giovanni Lorenzini Foundation (Milan, Italy), including vaccine experts active on the web, as well as representatives of citizen, patient and healthcare workers associations. The addressees were balanced according to three geographical areas, northern, central, and southern Italy and the largest islands (Sardinia and Sicily), corresponding to regions with

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different periodic COVID-19 prevalence, the highest being in northern Italy.[6] Recipients were free to fill in the questionnaire and were asked to forward the link to others, without communicating back their list of addressees. The same link was posted to the public on the Foundation's Facebook page. The questionnaire was composed of two pages: on the first page, participants were provided with information about the rationale and scope of the survey, i.e. to gather perceptions as well as modalities and abilities to collect, understand, and use information about vaccination, including candidate COVID-19 vaccines. Respondents were asked to provide honest answers, were not given any incentives for participation and could reply only once to the survey. They were informed that proceeding to the second page of the survey and completing the questionnaire constituted consent. No targeted replies were purchased. Participants could send answers via PC, tablet, or smartphone.

The survey was aimed at Italian adult individuals, aged 18 y and older, who were interested looking for information about future COVID-19 vaccines, and/or other vaccines via the media. No other exclusion criteria were applied. It was composed, in total, of 29 questions, including seven for main demographic data (age group, sex, native language, educational level, occupational status, geographical area of residence) and sources of information. The remaining questions are shown in the table in Appendix 1. Five closed questions (categorical variables) were about attitudes and perceptions regarding future COVID-19 vaccines. Three closed questions assessed the behavior toward current immunization practices (including if receiving or not past and future seasonal influenza vaccine). Moreover, two questions used a 4-point Likert scale to evaluate participants' beliefs regarding two statements about vaccinations: 'I am not favorable to vaccines because they are unsafe' and 'There is no need to vaccinate, because natural immunity exists,' considered as ordinal variables (Appendix 1).

The VL levels were assessed by adapting 12 questions from a self-reported questionnaire for adulthood vaccination[7] built on the Ishikawa test for chronic non-communicable diseases,[8] which has already been validated for content and construct.[9] Four items of the questionnaire were aimed at assessing functional VL and eight items evaluated interactive-critical VL (Appendix 1), according to Nutbeam's definition.[10] From the psychometric point of view, functional VL questions were mainly about language, involving the semantic system, while the interactive-critical questions focused more on cognitive efforts, such as problem-solving and decision-making. Each response was rated with a 4-point Likert scale (4 – never, 3 – rarely, 2 – sometimes, 1 – often, for the functional questions; 1 – never, 2 – rarely, 3 – sometimes, 4 – often, for the interactive-critical questions). The score was obtained from the mean value of the answers to each scale (range 1 to 4), a higher value corresponding to a higher VL level. These variables were treated as numerical, as in previous studies where comparable instruments were employed.[8,9,11,12]

Statistical analysis was carried out using MedCalc Statistical Software version 18.2.1 and XLSTAT software version 2014.5.03,[13,14] by means of descriptive tables summarizing percentages, means, standard deviations (SD), confidence intervals (CI), medians, and non-parametric tests, as data did not follow a normal distribution (see results). Spearman's correlation coefficient was calculated to determine the relationships between the VL scales with other ordinal/numerical variables; chi-squared, Kruskal-Wallis, and Mann–Whitney tests were used for categorical and ordinal variables. The internal consistency of the VL scales was assessed through the Cronbach's alpha coefficient. A Principal Component Analysis (PCA) was conducted to investigate how the questions of the functional and interactive-critical VL scales were related to one another and to assess whether the underlying components (factors) and each question's load on the components could be identified as anticipated. For each analysis, an alpha level = .05 was considered as significant.

The study was performed following the Declaration of Helsinki as revised in 2013 and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) guidelines.[15] The Scientific Board of the Lorenzini Foundation approved the survey. Necessary measures were taken to ensure anonymity, including the privacy policy adopted by SurveyMonkey, and informed consent of participants was requested. Answers were collected instantly, right at the time when the first results of Phase I trials for the first SARS-CoV-2 vaccines were communicated by the media (end of May 2020).

Results

Eight hundred eighty-five (885) answers were collected during 2 weeks, starting June 6, 2020, mainly through the web link. Most of the participants (N = 496, 56%) answered during the second week. Answers to functional and interactive-critical questions showed good/acceptable internal consistency (Cronbach's alpha = 0.8500 and 0.7672, respectively); dropping progressively each variable, lowest values observed were 0.7857 for the functional and 0.7274 for the interactive-critical scale. PCA showed two components accounting for 49.49% of the total variability. In order to clarify relationships among the items, a Varimax-rotation was applied, showing that all functional VL questions loaded on one component, while all communicative-critical questions loaded on the other component (Table 1, Figure 1). Each question's load on the two factors could be identified as anticipated, i.e. a close correlation was observed between the questions within the functional scale and those within the interactive-critical one.

The main demographic characteristics of participants are reported in Table 2. Half of the participants were males and 98% were native Italian speakers. Almost one

Table 1. Principal Component Analysis (PCA): correlations between questions and components (factors) after Varimax rotation. VL functional questions[1–4] and interactive-critical questions[5–12] loading on two different components (Factor 1 and Factor 2): values in bold correspond for each variable to the factor for which the correlation was the greatest.

Questions	Component (Factor) 1	Component (Factor) 2
1	0.0590	**0.7664**
2	0.1049	**0.8583**
3	0.0436	**0.8677**
4	0.0768	**0.8240**
5	**0.6405**	−0.0387
6	**0.5955**	0.2506
7	**0.6838**	0.1113
8	**0.5775**	−0.0136
9	**0.5086**	−0.0301
10	**0.5397**	0.0162
11	**0.6735**	0.1515
12	**0.6831**	0.1529

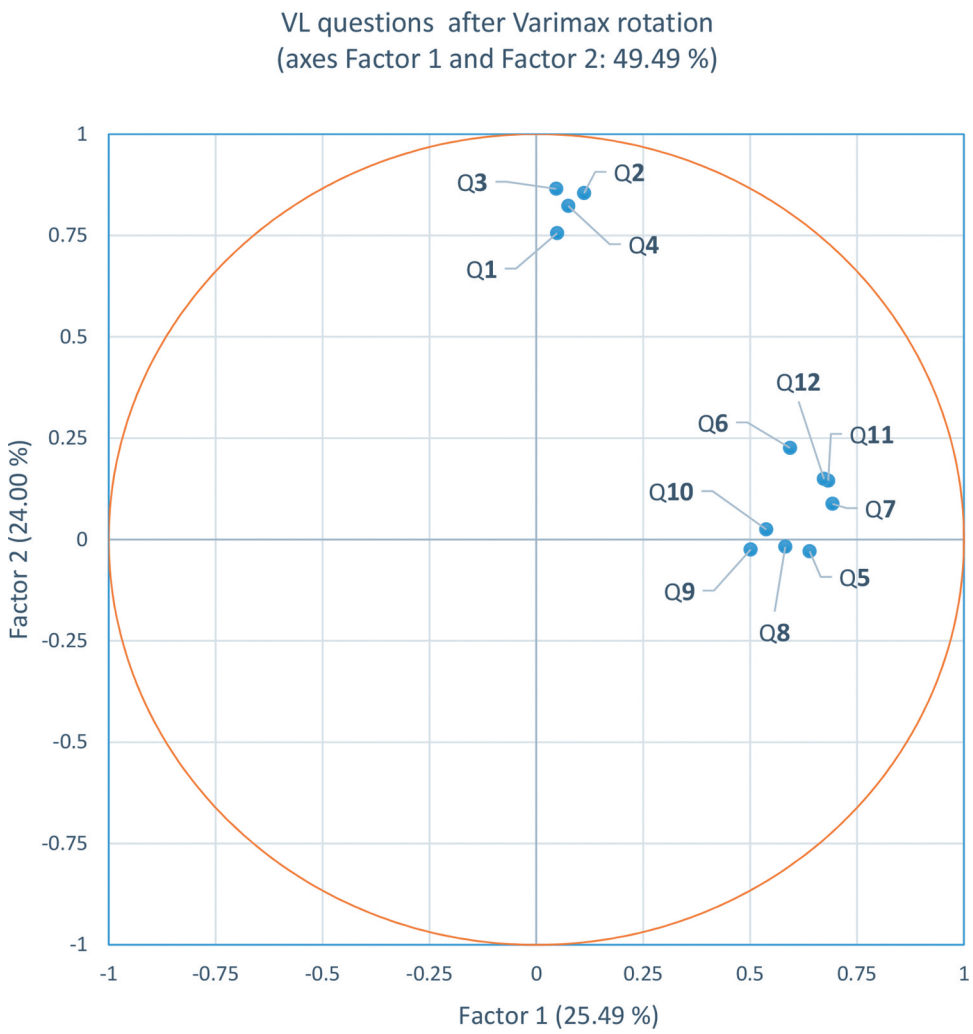

Figure 1. Principal Component Analysis (PCA): correlation circle between questions and components after Varimax rotation. Projection of the functional VL questions (Q1–Q4) and the interactive-critical VL questions (Q5–Q12) on two components (Factor 1 and Factor 2), representing 49.49% of the total variability. Variables close to each other were significantly positively correlated.

quarter were in the 18–30 y age category, 37% in the 31–50 and 31% in the 51–65 y age group, while only 9% were over 65.

Information sources most frequently used by the respondents were internet (72%), social media (47%), and TV (49%), followed by journal-newspapers (31%) and radio (11%); other sources accounted for 22%. About 40% of respondents had a secondary and 54% a tertiary educational degree; 53% were resident in central, 31% in northern, and 16% in southern Italy. About 60% were employed (15% were healthcare workers), 6% were unemployed, 11% retired, 14% students, and the remaining participants had other occupations.

Vaccine literacy (VL) score

The mean score of functional VL was 2.92 ± 0.70 (median 3.0), while the interactive-critical score was 3.27 ± 0.54 (median 3.4), out of a maximum of 4 (Table 3). The functional VL score was lower in females than males ($P < .05$, two-tailed Mann–Whitney) while

Table 2. Main demographic characteristics of the participants.

	Respondents (%)
Total population	885
Males (%)	442 (49.9%)
Females (%)	443 (50.1%)
Age class	
18–30 (%)	206 (23.3%)
31–50	327 (36.9%)
51–65	270 (30.5%)
> 65	82 (9.3%)
Residence Area	
Northern Italy	260 (30.4%)
Central Italy	455 (53.2%)
Southern Italy & Islands	140 (16.4%)
Education	
Primary	37 (4.2%)
Secondary	356 (40.2%)
Tertiary	478 (54.0%)
Other	14 (1.6%)
Occupational status	
Employed	532 (60.1%)
Non-employed	54 (6.1%)
Retired	99 (11.2%)
Students	125 (14.1%)
Housewives	17 (1.9%)
Other	58 (6.6%)

the interactive-critical scores were 3.28 ± 0.55 and 3.26 ± 0.52, respectively (non-significant difference). Although no cutoff value has been established for the tool employed in this survey, a 'limited' VL (score value ≤ 2.50) was observed in 33% persons for the functional and 11% for the interactive-critical scale.

No significant differences between age groups of participants were observed for the functional VL scale, but the interactive-critical mean score was significantly higher between 31 and 65 y of age ($P < .001$, Kruskal–Wallis) (Figures 2 and 3). Both functional and interactive-critical skills were associated with the area of residence of respondents, with the lowest functional and interactive-critical scores in central Italy ($P < .05$ and $P < .001$, Kruskal–Wallis, respectively). Regarding the relationship between VL and employment status, significant differences were observed between the different occupations for both the functional and the interactive-critical scale ($P < .001$, Kruskal–Wallis), the highest score being among healthcare workers, as expected (VL functional score = 3.21; interactive-critical score = 3.45).

Attitudes and perceptions about COVID-19 vaccines

Observed attitudes and perceptions on future COVID-19 vaccines were mostly positive (Table 4), with affirmative responses between about 80% and 90% for all questions, except question n.3 ('*Will Authorities succeed in vaccinating the entire population?*') where 66% (n = 584) of respondents replied positively. There was no association between perceptions about COVID-19 vaccines with age groups, except for questions n.3 and n.5 ('*Should children be vaccinated too?*'), younger participants providing more affirmative answers (chi-squared, $P < .05$), and with gender, except for question n.3 and n.5 (males providing more affirmative answers – chi-squared, $P < .001$ and $P < .05$, respectively).

Intention to be vaccinated against COVID-19 was very high (92% – n = 816), but not age related: it was overall significantly higher than that of receiving next seasonal influenza vaccine ($P < .001$, chi-squared).

Behavior toward current vaccinations

About 41% (n = 366) of respondents claimed they had been vaccinated for influenza the previous year and 66% (n = 588) declared their intention to receive a flu shot during the next season (Table 4). Both variables were significantly associated with higher age ($P < .001$, Kruskal–Wallis), not with gender; 73% (n = 649) stated they would be willing to be vaccinated against other infectious diseases.

Beliefs about vaccinations

The majority of respondents disagreed completely (Likert score 4/not at all) with both statements: *'I am not favorable to vaccines because they are unsafe'* (83%) and *'There is no need to vaccinate because natural immunity exists'* (84%). Much fewer respondents were partially in disagreement (13%, n = 117 and 12%, n = 106, respectively) and few were partially in agreement (3%, n = 27, and 2%, n = 20, respectively). Answers in total agreement were low, 11% (n = 10) and 14% (n = 12), respectively.

Correlation of VL with other variables

There was a significant correlation between the functional and interactive-critical VL scores (r = 0.191, $P < .001$).

Correlations between VL scores and other ordinal/numerical variables are reported in Table 5: there was a significant correlation between both VL scales and higher educational levels, as well as more positive beliefs about vaccination. For age, there was only a significant correlation between higher age groups with the interactive-critical scale. Positive beliefs about vaccination were significantly correlated with higher education, not with age.

Regarding correlation with the categorical variables (Table 4), no significant association was observed between functional VL score and positive attitude/perceptions on future COVID-19 vaccines, except for question n. 3 ('*Will Health Authorities succeed in vaccinating the entire population?*') ($P < .05$, Kruskal–Wallis), while the association was significant between interactive-critical score and replies to all the five questions (P values between < .05 and <.001, Kruskal–Wallis). All associations between functional as well as interactive-critical VL scores and positive behavior toward current vaccinations (i.e. acceptance of flu and other vaccines) were significant.

Frequencies of positive answers regarding perceptions about future COVID-19 vaccines and behavior toward current vaccines were generally higher during the second week of data collection, along with age of the respondents, as well as educational and VL levels. Functional VL score was 2.83 ± 0.68 (first week) and 2.99 ± 0.68 (second week) ($P < .001$, Mann–Whitney), while the interactive-critical scores were 3.07 ± 0.55 and

Table 3. VL functional and interactive-critical scores of the total, male, and female populations.

	Functional mean score (SD) [95% CI]	Interactive-critical mean score (SD) [95% CI]	Functional Median (25–75 P)	Interactive-critical Median (25–75 P)
Total (N = 885)	2.92 (0.70) [2.87–2.97]	3.27 (0.54) [3.23–3.30]	3.00 (2.50–3.50)	3.38 (3.00–3.66)
Male (N = 442)	2.99 (0.68) [2.92–3.05]	3.26 (0.52) [3.21–3.31]	3.00 (2.50–3.50)*	3.38 (3.00–3.63)
Female (N = 443)	2.85 (0.72) [2.77–2.92]	3.28 (0.55) [3.22–3.38]	3.00 (2.25–3.25)*	3.38 (3.0 –3.75)

*P <.05, Mann–Whitney.

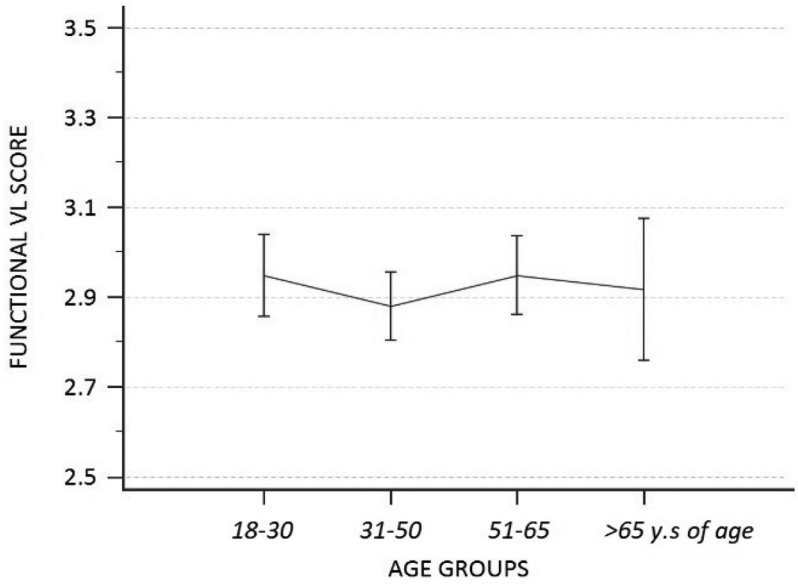

Figure 2. Observed functional Vaccine Literacy (VL) scores, visualized as mean and 95% C.I. (error bars), according to age groups.

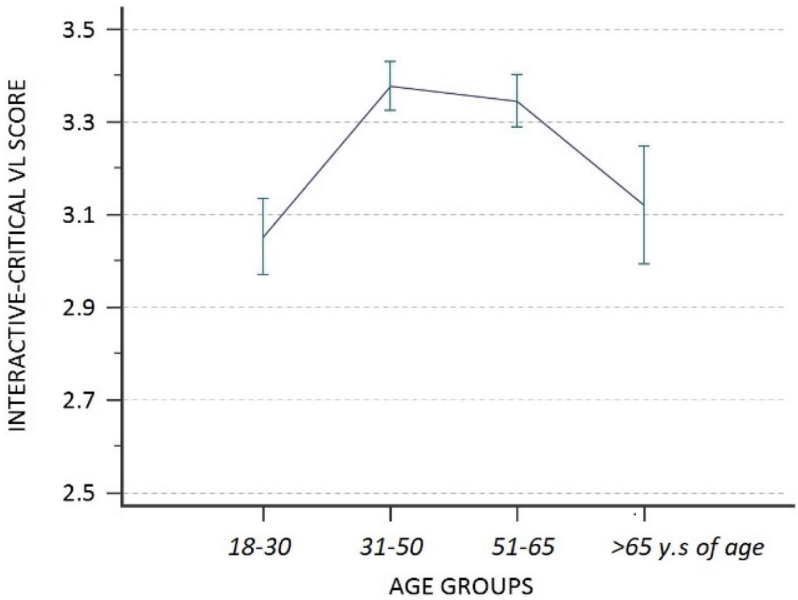

Figure 3. Observed interactive-critical Vaccine Literacy (VL) scores, visualized as mean and 95% C.I. (error bars), according to age groups.

3.42 ± 0.47 during the first and second weeks of data collection, respectively ($P < .001$, Mann–Whitney). Participants willing to be vaccinated against COVID-19 were 88% (n = 342) and 96% (n = 474) of respondents during the first and the second week, respectively (no significant difference).

Discussion

Main findings

The average VL scores for both the functional and interactive-critical scales were relatively high (2.92 and 3.27, respectively) and comparable to those observed from one study carried out prior to the current outbreak, where a very similar tool was administered via paper-and-pencil to a selected population who were attending the waiting rooms of public health offices.[9] In that study, the average functional VL score was higher than the interactive-critical one, while results of this survey have shown the opposite, with a higher interactive-critical score, comparable to that reported in other publications, where analogous instruments were employed face-to-face to assess parents' health literacy skills about their sons' vaccination.[11,12] Noteworthy, both these studies showed that individuals with higher levels of interactive and critical health literacy were less likely to comply with the vaccination protocol, while functional health literacy did not show a negative association with compliance. Authors explain this by the possibility

Table 4. Positive and negative attitudes/perceptions about future COVID-19 vaccines and behavior toward current vaccines, and significance level of their association with vaccine literacy (VL) scores, age, and gender (significant values in bold).

			VL functional score		VL interactive-critical score		Age groups	Sex
Questions about COVID-19 vaccines	Answers	N (%)	Mean (SD)	P, Kruskal-Wallis	Mean (SD)	P, Kruskal-Wallis	P, chi-squared	P, chi-squared
1 – Will it be possible to produce safe and efficacious vaccines?	Yes	792 (89%)	2.93 (0.70)	=.354	3.28 (0.54)	**=.014**	=.180	=.100
	No	95 (11%)	2.84 (0.76)		3.15 (0.53)			
2 – Will you get vaccinated, if possible?	Yes	816 (92%)	2.93 (0.70)	=.491	3.30 (0.52)	**<.001**	=.165	=.103
	No	69 (8%)	2.86 (0.70)		2.98 (0.63)			
3 – Will Authorities succeed in vaccinating the entire population?	Yes	584 (66%)	2.97 (0.68)	**=.003**	3.34 (0.50)	**<.001**	**=.030 (1)**	**<.001 (3)**
	No	301 (34%)	2.82 (0.73)		3.13 (0.57)			
4 – Would you pay a fee to be vaccinated?	Yes	739 (84%)	2.92 (0.70)	=.823	3.31 (0.52)	**<.001**	=.940	=.856
	No	146 (16%)	2.90 (0.73)		3.05 (0.57)			
5 – Should children be vaccinated too?	Yes	768 (87%)	2.93 (0.70)	=.485	3.29 (0.53)	**<.001**	**=.037 (1)**	**=.023 (3)**
	No	117 (13%)	2.88 (0.71)		3.10 (0.56)			
Questions about current vaccines								
1 – Have you been vaccinated against flu last season?	Yes	366 (41%)	3.05 (0.70)	**<.001**	3.38 (0.49)	**<.001**	**<.001 (2)**	=.785
	No	519 (59%)	2.83 (0.69)		3.19 (0.56)			
2 – Will you get vaccinated against flu this year?	Yes	588 (66%)	2,98 (0.71)	**<.001**	3.36 (0.49)	**<.001**	**<.001 (2)**	=.176
	No	297 (34%)	2.80 (0.68)		3.09 (0.57)			
3 – Do you plan to be vaccinated against other infectious diseases?	Yes	649 (73%)	2.97 (0.70)	**=.007**	3.33 (0.51)	**<.001**	=.644	=.543
	No	236 (27%)	2.82 (0.70)		3.11 (0.57)			

(1) = less positive answers in age group >65 y with respect to the other groups.
(2) = positive answers progressively increasing with age (chi-squared for trend: P <.001).
(3) = more positive answers among males.

Table 5. Spearman rank correlation coefficients (r) and significance levels between ordinal and ordinal/numerical variables observed in the survey (significant P values in bold).

		Educational level	Age group	Belief 1st statement	Belief 2nd statement
FUNCTIONAL Vaccine Literacy	Correlation coefficient	0.120	0.011	0.196	0.140
	Significance Level P	**<.001**	=.741	**<.001**	**<.001**
	N	871	885	885	885
INTERACTIVE-CRITICAL Vaccine Literacy	Correlation coefficient	0.159	0.089	0.234	0.196
	Significance Level P	**<.001**	**=.008**	**<.001**	**<.001**
	N	871	885	885	885
EDUCATIONAL LEVEL	Correlation coefficient		0.129	0.110	0.103
	Significance Level P		**<.001**	**=.001**	**=.002**
	N		871	871	871
AGE GROUP	Correlation coefficient			−0.042	0.033
	Significance Level P			=.216	=.331
	N			885	885

Belief 1st statement: 'I am not favorable to vaccines because they are unsafe.'
Belief 2nd statement: 'There is no need to vaccinate because natural immunity exists.'

that contradictory and misleading information may be difficult to evaluate, even for people with high literacy skills.

No significant association was observed between functional VL score and positive perceptions about future COVID-19 vaccines, except for one question, while the association was highly significant between all questions and the interactive-critical score. The high percentage (>90%) of participants willing to receive COVID-19 vaccines, when available, was particularly relevant. Interestingly, the proportion of individuals not willing to be vaccinated during the first week of the survey (13%) was similar to that shown in another inquiry (15% contrary or unfavorable to receive the vaccine) conducted in Italy a few weeks before, in May 2020, on one-thousand individuals

aged between 18 and >60 y.[16] Moreover, the intention to be vaccinated improved in the second week of the survey, from 88% to 96%, along with a significant increase in respondents and positive perceptions about future COVID-19 vaccines. This corresponded, time-wise, to the announcement (June 13, 2020), largely reported by the media, of the agreement between Europe's Inclusive Vaccines Alliance (IVA) and a vaccine manufacturer to supply massive doses of vaccine, with deliveries starting by the end of 2020. However, these results might also be related to the different demographics of participants during the second week of data collection in respect to the first one.

A relatively high percentage of participants stated that they had been vaccinated against influenza (about 40%), which is contrary to previous knowledge considering the low proportion of respondents over 65 y of age, who are the main target group of flu vaccine recommendations. Also, the low frequency of respondents willing to receive the flu shot in the upcoming season seems to be contradictory, when compared to the high percentage of individuals favorable to be vaccinated against COVID-19, and other infectious diseases. This is surprising because many authorities, scientific bodies, and the media have been strongly recommending seasonal influenza vaccination for different reasons, i.e. to reduce the burden of both epidemics expected next winter, to protect the most frail individuals and also because of the suggestion of a possible association – reported by some Authors – between lower COVID-19 related mortality and morbidity in persons who have been vaccinated against influenza.[17,18] These observations reflect a common problem about understandings of the value of flu vaccination and suggest that the positive attitude toward immunization against COVID-19 and other infectious diseases are based more on emotional aspects linked to the present infodemic, rather than on correctly perceiving a potentially upcoming risk of a simultaneous epidemic of COVID-19 and seasonal influenza. All this reinforces the need to improve medical communication.

Regarding beliefs about vaccination, the vast majority of participants disagreed completely with the negative statements about the relevance of vaccination. However, a proportion of them, though small, were only partly in disagreement and some were partially in agreement. The strong correlation between the positive opinions about vaccination, levels of education and VL of respondents, confirms the importance of improving the health literacy skills through targeted interventions.

Relevance and impact

To our knowledge, this is one of the first web surveys to assess health literacy skills about vaccination: it has been carried out in a time when COVID-19 vaccines were under early development. The results may possibly be useful for the implementation of other larger studies and define communication strategies. The rapid development of the COVID-19 pandemic has called for people to acquire and apply health information, and adapt their behavior at a fast pace.[5] This has stimulated motivation and abilities to look for accurate medical information. Indeed, the huge amount and variety of news lead to many individuals looking for accurate and reliable information, checking the credibility of sources and discussing with other people, thus increasing their interactive and critical skills. Yet, health literacy and the ability to search for accurate information can also be related to the characteristics and educational level of the individual. On the other hand, the functional skills were challenged by the complexity and technicality of many news and information, thus explaining the lower functional score, also in highly educated persons.

When COVID-19 emerged rapidly, health literacy, already considered important for non-communicable diseases, has appeared relevant also for the prevention of infectious pathologies. Information about vaccinations is quite complex and its comprehension requires certain abilities, more than just literary skills, i.e. being able to understand healthcare-specific language.[19] These capacities are determined not only by an individual's skills but also by the complexities of the healthcare system that can increase the communication demands placed on people.[20]

The concept of VL has been built on the same idea of health literacy: it has been defined as '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.'[21] Vaccine hesitancy has emerged for some years, generating refusal or delay in acceptance of vaccinations. This behavior results from a complex decision-making process that is influenced by different factors summarized into the so-called "3 Cs" and following models, including Complacency, Confidence, and Convenience.[22,23] In particular, vaccination convenience is a significant factor when physical availability, willingness-to-pay, accessibility, language, and health literacy affect vaccine uptake. Yet, limited health literacy is not taken into account frequently, although it is considered an important component and even if it is accepted that the success of communication strategies is limited by the difficulties in interesting low-literate individuals.

Health literacy becomes even more important in the context of the COVID-19 pandemic, considering the large amount of contradictory news provided by scientific as well as lay sources, including those about candidate SARS-CoV-2 vaccines. Health literacy might help people to recognize the reasons behind medical recommendations and consider the outcomes of their possible actions. It is even more topical to prepare individuals for situations that require rapid reaction such as during a pandemic. Infodemic generates an overload of information that may have negative impact on the behavior toward all recommended vaccinations. This may increase the risk of further decreasing vaccine coverage rates, as the pandemic lock-down has already caused a reduction of the immunization practices.[5,24]

Strengths and limitations

The convenience sampling adopted for this survey is a limitation of the study. Other limitations are common to most of online surveys and are related to low participation of people with lower educational levels and the elderly. In Italy, only 42% of individuals between 65 and 74 y of age surf the web (compared to almost 90% of the 18–50 y classes), and TV and print media are their main sources of access to information.[25,26] Another limit was that the survey was carried out at the time of the reopening (second and third weeks of June 2020),

following the lockdown due to the COVID-19 pandemic, when the emotional impact was still relevant. This might affect the generalization of the results. In addition, the data presented in this study are self-reported and partly dependent on the participants' honesty and web abilities, as for similar surveys online.

However, the findings from the survey provide valuable information about the VL levels of a sample of a relevant part of the Italian population, in addition to their perceptions of COVID-19 vaccines, behavior toward flu vaccines, and beliefs about vaccination, in general. This preliminary inquiry shows that self-reported online tools can provide realistic assessment of health literacy levels, as attested by the good internal consistency and component loading at the PCA of both VL scales. Moreover, VL skills detected were comparable to those observed in previous studies using similar instruments.

Future research

Other similar studies are needed, including larger and more representative groups of the population, with the aim of improving knowledge about the relevance of health literacy skills of the public, in particular about the vaccinations during epidemics, and tailoring specific interventions to increase them where necessary, in addition to adapting health communication and counteracting vaccine hesitancy. Health literacy is relevant for people in need of information and services, as well as for healthcare workers and individuals who provide vaccines and access to them. Although difficult, during the current pandemic it has been suggested it is still possible to enhance health literacy.[27]

Conclusions

Rapid online surveys are a practical method to assess and trail perceptions and attitudes during rapidly evolving infectious disease outbreaks, especially when face-to-face research is restricted due to infection control measures such as lockdowns. Along with health system's, individual preparedness is key for solving complex real-life problems. Ensuring that the public is informed properly about a condition like COVID-19 could reduce unnecessary anxiety, improve behavior, and reduce disease transmission. Web surveys are also useful to prepare communication strategies: for their fruitful realization, VL levels of the general population should be considered. This preliminary inquiry shows that self-reported online tools can provide realistic assessment of vaccine literacy: skills detected were comparable to those observed in previous studies using similar instruments, validated using direct questioning methodologies.

Authors' contribution

LR Biasio drafted the study protocol and the report, and carried out the statistical analysis; LR Biasio, G Bonaccorsi and C Lorini formulated the questionnaire and reviewed the results and the analysis; S Pecorelli reviewed the questionnaire and the rationale; all Authors reviewed and approved the final manuscript.

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Disclosure of potential conflicts of interest

No competing interests declared by the Authors.

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Appendix 1

Translated from Italian – *Tools employed to assess skills, perceptions, attitudes, behavior, and beliefs*

Variable	Measure and Items	Assessment (score)
VL functional skills	**When reading or listening to information about future COVID-19 vaccines or current vaccines**: (1) Did you find words you didn't know? (2) Did you find that the texts were difficult to understand? (3) Did you need much time to understand them? (4) Did you or would you need someone to help you understand them?	Numerical – 4 points Likert scale • Often (1) • Sometimes (2) • Rarely (3) • Never (4)
VL interactive/critical skills	**When looking for information about future COVID-19 vaccines or current vaccines**: (1) Have you consulted more than one source of information? (2) Did you find the information you were looking for? (3) Have you had the opportunity to use the information? (4) Did you discuss what you understood about vaccinations with your doctor or other people? (5) Did you consider whether the information collected was about your condition? (6) Have you considered the credibility of the sources? (7) Did you check whether the information was correct? (8) Did you find any useful information to make a decision on whether or not to get vaccinated?	Numerical – 4 points Likert scale • Often (4) • Sometimes (3) • Rarely (2) • Never (1)
COVID-19 vaccines perceptions and attitudes	**About future COVID-19 vaccines**: (1) Will be possible to produce safe and efficacious vaccines? (2) Will you get vaccinated, if possible? (3) Will Health Authorities succeed in vaccinating the entire population? (4) Would you pay a fee to be vaccinated? (5) Should children be vaccinated too?	Categorical YES/NO
Current vaccines behavior	**About current vaccines**: (1) Have you been vaccinated against flu last season? (2) Will you get vaccinated against flu this year? (3) Do you plan to be vaccinated against other infectious diseases?	Categorical YES/NO
Beliefs about vaccination	**How much do you agree with the following statements**: (1) *'I am not favorable to vaccines because they are unsafe'* (2) *'There is no need to vaccinate because natural immunity exists'*	Ordinal 4 points Likert scale • Totally (1) • A little (2) • Partially (3) • Not at all (4)