Research paper

Do quality markers for health websites affect the perception of vaccination webpages?

ABSTRACT

As people's health, and in some cases even their lives are at stake, the quality of health information on the web becomes a prime public health concern. Attempts at measuring or certifying quality usually use a set of quality markers, but their individual contribution to overall quality, and further to user perception and attitudes, is largely unknown. This study aims at assessing this contribution, using the topic of vaccination. It combines data from three sources, a survey participants filled in after completing an information search task, records of the webpages visited during that task, and a content analysis of these webpages determining the presence or absence of quality markers and the pages' tone towards vaccination. Results show that the tone of the webpages participants rated and were exposed to, is highly correlated with their attitude towards vaccination. Markers shown to be associated with high quality were also correlated with attitude, in particular when they were related to the quality of information content (such as "medical ownership", "specific accreditations" of health content and reporting "benefits of treatment/vaccination") rather than esthetic/visual and design markers. The results suggest that the approach to measuring the quality of health websites using such markers is both necessary and promising.

KEYWORDS

Health information quality; online health information seeking; vaccination; online search

1 Introduction

The technological advancement in computing devices, their diffusion and the growth of the Internet have changed peoples' daily lives in the last decade and half [1,2]. This is especially true for the availability of health information on the Internet and its use. The use of Internet for health-related purposes has grown, and consequently there was an increase in eHealth services [3–8]. Online health information seeking is becoming a recurrent activity of people's everyday live [9]. Indeed, many studies have reported that looking for medical information on the Internet was the first resort by individuals [4,9–12], with a general search engine (e.g. Google, Bing, Yahoo, etc.) as the typical starting point [9,13–15].

Research on the health information seeking process has concerned itself with (1) the motives and antecedents [4,10,16–24], (2) the search behavior itself, including strategies, topics and the use of search engines and their efficiency [4,10,12,14–30], and (3) its consequences, for instance on health decisions [2,9] and medical consultations and the doctor-patient relationship [31–34].

1.1 Quality of health-related Internet content

As the interest in using the Internet for seeking health-related content was growing, research began to question the quality of online health information [35–39]. Given that the Internet offers the opportunity to everyone with a connection to publish health information, studies have found a high variance in the quality of content [39–45]. As a reaction, international organizations and well-known research institutions created various sets of evaluation criteria and started multiple initiatives for assessing the quality of health-related information available online (e.g., Stanford Persuasive Tech Lab, The Health On the Net Foundation (HON) code of conduct [46], DISCERN [47]). The number of these initiatives increased steadily in the last decade [48–50]. By far the largest share of work on assessing information quality takes the following logic: First, quality criteria are defined, and secondly they are applied to health websites [51,52]. The application can happen automatically by machine or by human coders or by the users themselves. Some organizations certified website quality if the application

procedure has positive results, for instance by the HON code seal. Accuracy, completeness [39,53], consistency, security, timelines [53], readability, design, disclosures, and cited references [39] are among the major recurrent quality criteria used in the literature. Throughout this study, we use marker, feature or criterion interchangeably to refer to a website characteristic that is considered a quality indicator.

Simplifying the typology used in an earlier part of the study [54], three types of quality markers can be distinguished: those related to the Internet and its potentialities in general, those related specifically to health communication, and those specific to the health topic under study, in our case vaccination. Internet-related markers refer to webpage design and interactivity (assessing the use and usability of features typical of the Internet such as the functioning of links, ease of navigation, etc.). Health-specific markers relate to features that indicate the adherence to standards typical of health communication such as currency, completeness and comprehensiveness of information. Vaccination-specific markers relate to substantive content of the website relating directly to the health topic. Distinguishing these dimensions of quality markers helps to assess how much of the quality discussion and the definition of quality markers as a solution relates to specific versus general aspects.

The consequences and effects of quality markers are of interest to research. It is important to know whether quality markers are recognized as such, whether their perception affects the appreciation of the website, or whether they influence users' attitudes to the health subject addressed on a website. If website quality and appreciation and attitudes were unrelated, this would indicate that the quality discussion is largely pointless. Good quality would not translate into more positive attitudes, but shortcomings in quality would not increase vaccination opposition either. If, on the other side, good quality of websites and positive attitudes of their users were to go along, this would indicate the necessity of enforcing the efforts to enhance quality or at least to mark the websites where it can be found. This is why we address consequences of quality markers in this research.

Research has addressed the contribution of website features to the impression users form of them and other effects, also in dependence on the information seekers' characteristics (i.e. education, age, gender) [55,56]. For example the findings in [56] suggest that there exists a moderating effect for gender on the relationship between the characteristics and the overall impression of academic websites [56] (i.e. men appreciate more quality characteristics of a website such as quality of information, reliability of source, error freeness compared to women who value more the website's navigational aspects). Moreover, a study of critical incidents on the web [57] discussed how different characteristics would be attributed to trust (such as reviews or recommendations by friends) and distrust (complex layouts, design elements such as pop-ups). Changing the perspective of this research, another study, based on data collected from survey responses, tested the mediating role of perceived website quality between users' attitude to the Internet and their searching behavior using structural equation modeling. The results showed that the perception of a higher website quality increased users' willingness to spend more time on searching the information they needed [58].

A study of health-related websites proved to be especially inspiring for our analysis [59]. The authors looked at the role of 6 message characteristics and 7 structural features for users' perceptions of website credibility and attitudes about the searched health topic. The message characteristics were the presence of statistical information, testimonials, quotations, references/citations, message's author and currency. Structural features included third-party endorsements, images, physical address or telephone number, privacy policy statement, navigation menu, the name of the persons or organization operating the website and link(s) to external websites. The more structural features were present on a website, the more credible its users found it, and the more message characteristics were present, the more favorable attitudes about the health topic did users have [59]. Choosing the aggregate number of website features as independent variable, the authors noted that the study did not allow for investigating the influence of specific features. Moreover, the analysis was based on only one visited webpage per user offering a one-time impression that did not permit for inspecting the

dynamics of being exposed to multiple webpages with various features. In addition, there was no controversy or opposing argument in the health topics used for the searching task.

The bottom line of reviewing literature is that, in spite of an ample use of quality markers in the efforts to select and tag high-quality health websites, we hardly know anything about how single markers contribute to overall perceived quality, or which markers (their presence or absence) are the discriminative ones, the ones that contribute most to the formation of users attitudes to the health topic covered. This research aims at closing this gap.

1.2 Health topic

Vaccination is a controversial and relevant topic. The controversy evolves mostly around child vaccination, where opposing arguments and positions are abundant on the Internet [60], and relevance is the consequence of the fact that parents have to make decisions about vaccination. Since vaccination is considered one of the biggest breakthroughs in medicine, saving millions of lives, the arguments and information used against vaccination or aiming at discouraging people from vaccination have to be considered incorrect or dangerous. Therefore we think it is justified to consider the website's positive stance on vaccination as an indicator of quality. A website is considered a high quality if it strengthens favorable attitudes towards vaccination.

1.3 Hypotheses and research question

This article is concerned with the effects of quality-related features on attitudes to vaccination. It includes as predictors the pro- or con-vaccination tone of websites, the number and type of quality markers, and finally the effect of individual quality markers. It was argued above that websites with a favorable stance strengthen favorable attitudes in users. This however need not be so. To be sure, we hypothesize (to be specified later for methodological considerations):

1.3.1 Hypothesis 1

Health information seekers' attitude toward vaccination is predicted by the tone (either pro- or anti-vaccination) of the websites they visited in the context of a search task performed within an experiment (H1).

Not only website tone towards vaccination, but also the presence of quality markers is considered to predict attitude:

1.3.2 Hypothesis 2

The more intensely a health information seeker was exposed to quality markers, the more favorable towards vaccination his or her attitudes would be after exposure (H2).

1.3.3 Hypothesis 3

The features/markers assembled in the health-related and vaccination related dimensions are expected to be more discriminative than the markers comprised in the Internet-related dimension (design and interactivity) (H3).

By discriminative markers, we mean those that, when present, would serve as better predictors of users' attitudes towards vaccination.

1.3.4 Research question

Following up to these hypotheses, we ask which of these quality markers (respectively the exposure to them) will be the best predictors of attitude? (RQ1)

In other words, we seek to identify which markers that participants were exposed to are the most discriminative and hence predictive of participants' attitude toward vaccination.

2 Methods

Testing the hypotheses requires a set of websites looked at by a group of participants, content analysis of these websites for general tone on vaccination and the presence of quality markers,

observational data from information search and interviews with the participants to measure their attitudes to vaccination. These conditions can be met by a secondary analysis of experiments conducted by Allam et al. [61] that looked into the impact of search engine manipulation on the attitudes and beliefs towards vaccination. The manipulation created different ratios of anti-vaccination vs. pro-vaccination websites in the retrieved search results. This manipulation plays no role in the analyses reported in this article.

The experimental procedure was as follows. Participants entered a search query and were offered a search result page with 10 results. They then had 10 minutes time to search for information on vaccination on whatever search result pages they liked. A like/dislike button was attached to every search result (webpage). By clicking on these buttons, participants were able to rate the pages they read. As a visual indication for the rating action, the corresponding like/dislike button disappeared once it was clicked. When the 10-minute search phase was terminated, participants immediately filled out a post-exposure questionnaire.

2.1 Content analysis of webpages

Visited webpages were content-analyzed for the presence or absence of quality markers and their general tone towards vaccination. The latter was coded as 1 = anti-vaccination, 2 = neutral (undefined) and 3 = pro-vaccination.

The quality markers were extracted and adapted from the various literatures investigating the quality of health information [39,40,43–45,62–65], in addition to the attributes and criteria that are found in code of conduct or tool-based evaluation approaches (i.e. Hon code, JAMA benchmark, DISCERN). A total of 38 markers were coded as present or absent from every web page.

Two coders were employed, one of the authors (GS) and an undergraduate communication student familiar with content analysis and trained in applying the coding system (two training sessions of about 2 hours each). In a pilot test both raters independently assessed 20 webpages randomly selected from the initial sample (N=1394). The majority of categories were considered as comprehensible and easily applicable for both raters. A formal reliability assessment phase was then conducted (i.e. testing inter-

coder reliability for coding all investigated 38 markers) using 100 webpages randomly selected from the initial sample (N=1394). Cohen's kappa was used to evaluate the inter-coder reliability taking into account the probability of agreeing by chance. The minimum acceptable level of agreement was set at .60. Coefficients of the 38 markers were mostly high with an average of .90 and ranging from .70 to 1. The coding of the general tone towards vaccination marker achieved a kappa of .94. Appendix A reports the description of each marker used and the corresponding inter-coder agreement kappa value.

Webpages were discarded if they met the following exclusion criteria: they were non-English, they merely redirected raters to other web sources (e.g., index pages providing links to articles or news), they treated vaccination not at all or only marginally, they had not enough text or were delivered via .Pdf or similar formats. As a result, the final sample used for this study consisted of 1093 unique webpages.

2.2 Measures from post exposure questionnaire

Participants' attitude towards vaccination was the dependent variable in all analyses. The two main measures developed in Allam et al. experimental study [61] were used. The first was a 12-item scale, derived from factor analyses, that represented "skepticism/fear of vaccination side effects," explained 35% of the total variance and had reliability with Cronbach alpha equal to .88. The second was a factor measuring the acknowledgement of vaccination benefits, comprised of 4 items, explaining 12.34% of the total variance and having reliability with Cronbach alpha equal to .86. The original items comprised in each measure are reported in Appendix B. Moreover, these items were recently used in another health information seeking experiment where the emerged factors and corresponding items were similar and hence validating the ones used in the current study [66].

2.3 Data processing

In two cases, processed data rather than the data as measured were employed for the analyses. The first one concerns exposure to websites, the second one constituted a validity check of the quality markers.

Due to the nature of our experimental manipulation, many participants were deprived of something that is quite natural in many communication situations: selectivity. To compensate for this, the independent variables were not included in the analyses as described above, but in combination with the users' webpage rating. That means for instance the contact with a pro-vaccination webpage was counted towards contributing to positive attitudes only if the respondent liked the webpage. Similarly an anti-vaccination webpage that was disliked was counted as contributing to positive attitude, too. The other two cases, a pro-vaccination webpage that was disliked and an anti-vaccination webpage that was liked was counted as taking away from the positive attitudes. We speak of the *rated exposure* to webpages of different tone to refer to this variable. It is computed at the level of the participant as the percentage of liked pro-vaccination pages plus disliked anti-vaccination pages among all webpages exposed to, including those with the unclear tone or missing appreciation.

The quality markers were compiled from literature of all sorts. Not all of them were selected in the source literature based on empirical evidence. Given that we had to content analyze a large number of positive as well as negative websites, we had the chance to determine whether a given marker was really associated more with positive than negative websites. If this were not so, the given marker cannot be considered an indicator of quality. For a metric addressing this problem, the choice was on the likelihood ratio (to be further explained below) measuring the probability of a marker to be present on a pro-vaccination webpage to the probability to be present on an anti-vaccination one. The likelihood ratio served as an indicator of the association between webpages' tone and quality markers.

2.3.1 Testing Hypothesis 1

If H1 is true, we expect the rated exposure to be associated positively with acknowledgment of vaccination benefits and negatively with skepticism/fear of vaccination side effects. To test the

hypothesis, Pearson product-moment correlation between the rated exposure (independent variable) and each of the two attitude measures (dependent variables) was performed independently.

2.3.2 Testing Hypothesis 2

As described, the likelihood that a marker appears on a pro-vaccination webpage (number of such webpages divided by the total number of pro-vaccination webpages) is divided by the likelihood that a marker appears on an anti vaccination page. A $LR > 1$ indicates that a marker is more likely to be associated with pro-vaccination webpages, while $LR < 1$ signifies that a marker is more likely to be associated with anti-vaccination webpages. And LR equal to 1 means that there is no difference in the association of a marker with either tone; a marker is as likely to appear in pro- as in anti-vaccination webpages.

Before computing LR values, Laplace (Add-One i.e. $k=1$) smoothing was applied in order to take into account the issue of non-presence of markers in webpages of either tone (pro or anti). This procedure would simply add 1 count to all markers uniformly for both categories of webpages (the pro and anti category) and thus assigning small non-zero probability for non-present markers in one of webpages' tone category. Figure 1 reports the LR ratio after the application of Laplace smoothing for all 38 markers organized in their corresponding quality dimension.

Figure 1 Likelihood ratio of the quality markers measuring the degree of association of each marker to pro-vaccination webpage vs. anti-vaccination one (i.e. $LR(\text{Marker}) = \frac{P(\text{Marker}|\text{Provaccination})}{P(\text{Marker}|\text{Antivaccination})}$)

The next step, we split the markers into two groups, those associated with pro-vaccination pages ($LR > 1$) and those associated with the anti-vaccination pages ($LR < 1$). The rated exposure to a quality marker was again expressed as percentage. For markers associated with the pro-vaccination position (i.e. $LR > 1$), this was the share of pages liked among all pages visited that carried the marker. For markers associated with the anti-vaccination position (i.e. $LR < 1$), it was, correspondingly, the share of pages *disliked* among all pages visited that carried the marker. Thus, this measure indicates how much of a participant's exposure to a quality marker occurs in a context that can be assumed to reinforce pro-vaccination attitudes. H2 correspondingly posits that rated exposure is associated

positively with acknowledgment of vaccination benefits and negatively with skepticism/fear of vaccination side effects.

As there are 38 quality markers in this study with LR either greater than or less than 1, the procedure outlined yielded 38 independent variables each quantifying the rated exposure of the participants to the corresponding quality marker in the context of reinforcing pro-vaccination attitudes. Therefore each participant had a record that included his/her rated exposure on all 38 markers. A weighted average of all 38 variables was computed for each participant using the computed likelihood ratio of each corresponding marker. In other words, each rated exposure variable corresponding to a quality marker was multiplied by its marker's LR then the sum of all weighted variables was divided by the total sum of LR values of all markers. The LR values of markers associated with anti-vaccination websites ($LR < 1$) were reversed ($1/LR$). Following this procedure, markers more clearly associated with pro or anti websites exert a stronger influence on the computed weighted-average rated exposure variable. To test for H2, Pearson product-moment correlation between the computed weighted-average rated exposure variable and the two dependent variables (acknowledgment of vaccination benefits and skepticism/fear of vaccination side effects) was performed.

2.3.3 Hypothesis 3

Following the same logic of testing Hypothesis 2, to test the third hypothesis (H3), we repeated the analysis performed in H2 but this time applied for the three dimensions separately. That is instead of computing the weighted-average rated exposure variable for each participant based on all 38 markers; we did the computation based on each set of markers belonging to one of the three-quality dimensions. As a result, we get 3 weighted-average rated exposure variables for each participant; each corresponds to markers belonging to one of the three-quality dimensions. To test H3 we compute and compare the correlation between the three computed variables and the two attitude measures (acknowledgment of vaccination benefits and skepticism/fear of vaccination side effects) to get 3x2 correlation coefficients.

2.3.4 Research question

Significant associations iff (i.e. if and only if) observed in H3 would prepare for the final step of determining which individual quality markers contribute most strongly to the detected association between rated exposure and attitude. Hence, multiple linear regression is employed where each attitude measure is regressed on the rated exposure variables computed for each marker in the set of markers belonging to the quality dimension that showed to have a significant relationship in H3.

The analysis and the procedure for preparing the data set and computing the targeted variables were implemented in R version 3.0.2 (R Foundation for Statistical Computing, Vienna, Austria).

3 Results

The current analysis is based on all 197 participants of the experiment conducted by Allam et al. [61] 61.4% (121/197) were males and 38.6% (76/197) females. The nationalities of the participants were 0.5% (1/197) from England, 0.5% (1/197) from Hungary, 8.1% (16/197) from India, and 90.9% (179/197) from the United States. The participants' level of education was 17.8% (35/197) with high school level, 81.2% (160/197) with college or university level, and 1.0% (2/197) with vocational training. The mean age of the participants was 37.32 years (SD 11.39).

Participants made 4588 contacts with webpages/links, of which 1280 (27.89%) were discarded because they met the exclusion criteria. In the final sample (N=3308), 1602 visited webpages were pro-vaccination in the coding of general tone (48.43%), 1444 were anti-vaccination (43.65%), and the residual 262 were neutral or with an undefined tone toward vaccination (7.92%). Of the 3308 contacts with webpages, 2481 (75.0%) were liked, 715 (21.61%) were disliked, and 112 (3.39%) remained without an evaluation (no rating).

The 3308 contacts (i.e. visited webpages) comprise 1093 unique webpages of which 514 (47%) approved vaccination, 471 (43.1%) disapproved it and 108 (9.9%) were neutral or with an undefined tone. The majority of the unique anti-vaccination webpages held radical views and opposed all kind of

vaccines (N=430, whereas a minor part adopted a relatively moderate view and opposed only some immunizations (N=41).

Unique webpages on average displayed 5.56 (SD = 2.14) quality markers in the webpage design and interactivity dimension (ranging from 0 to 12), 7.67 (SD = 1.88) in the general health information quality dimension (ranging from 2 to 12), and 3.97 (SD = 1.75) in the vaccination-specific information quality dimension (ranging from 0 to 9).

Participants on average liked 12.59 (SD = 20.55) and disliked 3.63 (SD=4.46) webpages. These are the bases of the ensuing analyses.

3.1 Hypotheses testing results

3.1.1 Hypothesis 1

Users' rated exposure to visited webpages with a certain tone toward vaccination is significantly correlated with the users' attitude toward vaccination. The more the users liked pro-vaccination webpages and *disliked* anti-vaccination ones, the less skeptical or afraid of vaccination side-effects ($r(195) = -0.39, P < .001$) and more acknowledging of vaccination benefits ($r(195) = 0.37, P < .001$) they become. Hence the results support H1.

3.1.2 Hypothesis 2

The more participants on average liked webpages carrying markers associated with pro- more than anti-vaccination webpages and *disliking* webpages carrying markers more associated with anti-vaccination webpages, the less skeptical of vaccination side effects ($r(195) = -0.21, P < .01$) and more acknowledging of vaccination benefits ($r(195) = 0.16, P = .02$) they become. These results support the use of likelihood ratio as a metric for associating markers to webpage tone toward vaccination in addition to the computation of rated exposure variable, which showed to be also correlated with and thus predictive of the participants' attitude toward vaccination. Hence, H2 was verified.

3.1.3 Hypothesis 3

Results in Table 1 help in understanding which set of markers and hence which quality dimension contributes to the association between rated exposure and attitudes found in H2. It reports the correlations between weighted-average rated exposure (averaged for the markers belonging to one of the quality dimensions) and the two attitude measures. Weighted rated exposure to the markers belonging to the general health information quality dimension showed a significant negative correlation with skepticism/fear of vaccination side-effects ($r(195) = -0.20$, $P < .01$). Similarly, weighted rated exposure to markers in the vaccination-specific information quality dimension was negatively correlated with the same attitude measure ($r(195) = -0.15$, $P = .04$). When it comes to the acknowledgment of vaccination benefits, the only significant positive correlation detected was with the participants' weighted rated exposure to markers from the vaccination-specific information quality dimension ($r(195) = 0.19$, $P < .01$). Weighted rated exposure to markers belonging to the webpage design and interactivity quality dimension did not show a significant correlation with any of the two attitude measures. Hence, H3 is partially supported as the rated exposure to the markers belonging to the general health information quality dimension was significantly correlated only with the first attitude measure (skepticism/fear of vaccination side-effects) but not the second (acknowledgement of vaccination benefits).

Table 1 Correlation between weighted-average rated exposure to markers and attitudes for each quality dimension.

Quality dimension	Skepticism/fear of vaccination side-effects	Acknowledgement of vaccination benefits
Webpage design and interactivity	$r(195) = -0.08$	$r(195) = 0.136$
General health information quality	$r(195) = -0.20^a$	$r(195) = 0.134$
Vaccination-specific information quality	$r(195) = -0.15^b$	$r(195) = 0.19^a$

^a $P < .01$

^b $P < .05$

3.1.4 Research question

To further understand which markers dominate in the significant correlations obtained in Table 1, the attitude measures were regressed on participants' rated exposure to each quality marker in the investigated quality dimension. Tables 2 and 3 report the regression coefficients of the models that used markers from the general health information quality and vaccination-specific information quality dimension respectively.

Regarding the general health information quality dimension, the regression model predicting skepticism towards vaccination had two significant predictors represented by liking webpages having medical ownership and webpages having specific health accreditations such as a quality seal (e.g. HONcode). In other words, the more participants liked webpages having a medical ownership or a specific accreditation certifying the health information quality, the less skeptical and afraid of vaccination side effects they were.

Table 2 Estimated parameters of the regression model using rated exposure for each marker belonging to the general health information quality dimension

Independent variables	Dependent variable	
	Skepticism/fear of vaccination side-effects	
	Coefficients	Std. error
Intercept	-1.139	0.600
% Like of webpages carrying marker with LR > 1		
Title	0.014	0.014
Ownership	0.003	0.015
Medical ownership	-0.009 ^a	0.003
Date of last update	0.001	0.003
References	-0.005	0.003

Contact & feedback mechanism	0.015	0.015
Accreditations: Generic	0.001	0.002
Accreditations: Specific	-0.004 ^b	0.002
Advertising presence	0.004	0.009
Language	0.001	0.004
Privacy policy	-0.008	0.006
% Dislike of webpages carrying marker with LR < 1		
Target audience	0.002	0.007
Date of creation	0.005	0.003
Readability level	0.001	0.003
R ²	0.20	
AIC	564.64	

^aP<.001

^bP<.05

In a similar approach, the model using markers from the vaccination-specific information quality dimension showed to have a dominant significant predictor in the “Benefits of treatment” marker. That is the higher the percentage is of likes to webpages discussing the benefits of vaccination, the less skeptical of vaccination side-effects and the more acknowledging of vaccination benefits the participants were. Moreover, it is also worth noting that based on the akaike information criterion, the model that is using markers from general health information quality dimension fits better the skepticism of vaccination side effects compared to the one using markers from the vaccination-specific information quality dimension. Therefore, the “medical ownership”, “accreditations: specific” and “benefits of treatment” are the dominant markers, the exposure to which are significant predictors of the participants’ attitude toward vaccination. Identifying the latter discriminant markers is the answer to research question (RQ1).

Table 3 Estimated parameters of the regression model using rated exposure for each marker belonging to the vaccination-specific information quality dimension

Independent variables	Dependent variables	
	Skepticism/fear of vaccination side-effects	Acknowledgement of vaccination benefits

	Coefficients	Std. error	Coefficients	Std. error
Intercept	0.205	0.427	-0.243	0.430
% Like of webpages having marker with LR > 1				
Disease information	0.007	0.004	-0.008	0.004
Treatment information	-0.001	0.004	0.003	0.004
Benefits of treatment	-0.006 ^a	0.003	0.007 ^a	0.003
Definition of terms or (Q&A) formats	0.000021	0.002	-0.001	0.002
% Dislike of webpages having marker with LR < 1				
Risks of treatment: Low	-0.003	0.004	0.003	0.004
Risks of treatment: Severe	-0.006	0.006	0.004	0.006
Conflict of interest	0.004	0.003	-0.001	0.003
Alternative medicine or treatments	-0.001	0.003	0.001	0.003
Link to additional sources	-0.001	0.007	-0.001	0.007
R ²	0.07		0.07	
AIC	585.29		588.86	

^aP<.05

4 Discussion

This study provides evidence that the quality of webpages informing about health issues has consequences on perceptions and attitudes of webpage users. Consequences and attitudes are especially important in case of controversial health issues. The rated exposure, that is the combination of a website tone and quality with the users' appreciation or disappreciation of the site, is correlated with post-exposure attitudes among users. And the number of "true" quality markers (that is those of which the association with high-quality sites was corroborated by our data) present on websites visited is correlated with attitudes as well. First and foremost this relates to quality markers assessing the information content, among which "medical ownership", "accreditations: specific" and "benefits of treatment" are most influential in telling high- from low- quality websites. In line with our assumptions, this indicates that the way of defining quality by probing/investigating the presence of such markers is both necessary and promising.

This study used only one health-topic for its analyses, vaccination. But that does not mean the results are irrelevant for other topics. Quite to the contrary, we believe that they have some validity for other topics as well. The quality markers belonging to the webpage design and interactivity dimension and the general health information quality dimension could be also applied to other topics as they could be considered general features/markers characterizing websites and their comprising webpages. Moreover, the markers chosen for the condition-related dimension (the third quality dimension) are not specific to vaccination either but could be also used for evaluating the reporting style of other treatment information and to what degree it is explicit and transparent (i.e. reporting benefits and possible complications or side effects). These markers are close to the attributes and criteria found in quality evaluation tools such as DISCERN that is used extensively in the research literature [48]. The only thing needed is to substitute vaccine/vaccination by the treatment name under assessment.

This study took the attitudinal measure toward controversial health topic (vaccination) as yardstick for determining the overall quality of the website. Rated exposure based on the tone of the webpage is significantly correlated with the attitude of the participants toward vaccination. However, what is not obvious and this study tried to tackle is the relation between the assessment of the presence and absence of quality markers in the visited webpages and the way health information seekers perceive such markers in form of their effect on their attitude toward the health topic.

Based on the likelihood ratio, the set of markers that were more likely to be present in pro-vaccination webpages included multiple items and the same was the case for the set of markers that were likely to be present in anti-vaccination ones. However, based on the analysis, few rated markers were considered significant predictors of the users' attitude. This might suggest that health information seekers perceive only few of the quality markers that might be objectively present in webpages.

Moreover, the choice of likelihood ratio as a metric for establishing polarity to the webpage's tone showed to be a viable choice especially when used to weight the rated exposure of participants to webpages showing significant correlation with the attitude measures. More importantly, grouping the quality markers based on the quality dimensions they belong to, gave an insight into what markers and

consequently which quality dimension contributes to this significant relation with the attitude measures. As a result, what became clear is the non-contribution of the webpage design and interactivity quality dimension compared to the other two dimensions in the observed association with the attitude measures. This might suggest that quality markers related to the content of the webpages were weighed and considered more relevant by the participants compared to esthetic/visual and design markers.

Regarding the general health information quality markers, medical ownership and health-related accreditation by third-party were evidently lacking on anti-vaccination websites, but more importantly they were perceived more strongly by the health information seekers. This had a favorable effect on the attitudes of the participants toward vaccination. As medical ownership would provide a label for credibility and the accreditation from third-party would require that the websites comply at the minimum with a certain set of quality criteria, the outstanding importance of these compared to the other markers in the regression models might well be explained.

With respect to the topic-dependent quality dimension (vaccination-specific information quality dimension), the rated exposure to markers, unlike for the other dimensions, had a significant correlation with both attitude measures, with “benefits of treatment” as the only dominating marker.

As we only have one topic in this study, we cannot come up with a generalization that in every controversial medical topic, the same markers would dominate. However, we believe that these markers would also play an important role in the case of other topics related to diseases and treatments.

Overall, the findings in this study stress on the importance of the website quality factor in the health information seeking process as in the earlier reviewed studies [57–59]. Many of the current investigated markers are also found in tools such as DISCERN and the principles supported by the HON association. At the end, it seems what had the final word on predicting health information seekers attitude toward vaccination was determined by the quality of the content more than the design and the presentation of the information. This is by no means an invitation to abandon or take less care

of the design and visual parts of the webpages; it is rather an encouragement for health information providers to focus more on delivering high quality information content.

4.1 Limitations

Most influence processes in communication are affected by recipient selectivity, which in turn is constrained by the supply of communication material and the selection criteria of suppliers. In case of online health information seeking, an important constraint exists in the selection rules of the search engine used. The presence of such constraint is only realistic, but in our case the selection rules of Google were manipulated in the original experimental study. Due to the experimental manipulation, user selectivity was restricted. As the logic followed in the analysis used webpage evaluation (rated exposure) in combination with the quality markers for the prediction of quality, the restriction of selectivity will largely have been balanced out.

This study used only one health-topic for its analyses, vaccination. As we mentioned earlier we do not see this as limitation as the quality attributes used in this study could be applied for evaluating other controversial health topics. As a matter of fact, we see this as a call for more research in this area with different controversial health topics. It would be interesting to see for future studies what results would emerge if other controversial health topics were used and evaluated in a similar approach as this study presents.

4.2 Conclusion

This study presents and adds three main contributions to the literature. First, it showed the relation between the objective assessment of webpages (presence or absence of quality markers) and the way health information seekers perceive such markers (operationalized by the rated exposure variable) which significantly predicted participants' attitude toward the discussed health topic (vaccination in our case).

Second, the study identified the major quality markers, which serve as discriminative markers for determining the quality of the websites. Knowing which of these markers are considered by the health

information seekers and contributing to their acceptance of the website's content and position toward vaccination would help in tailoring and building health websites that are more persuasive and effective in conveying information on the subject.

Third, the implications of knowing the important quality dimensions and their corresponding quality markers plays an important role especially in deciding the relevance and importance of tool-based quality evaluation methods (i.e. DISCERN, HON principles). This becomes even more important when automated procedures will be developed for the evaluation of health information using such tools. By determining which quality dimensions and consequently their comprising markers have a strong impact on the health information seekers, the focus will be only on the development of algorithms that automate the evaluation and detection of such markers rather than the whole array of attributes investigated in the literature. This will result in higher benefit by reducing the computational time (in case of automated tools) and the time and effort spent on assessing online health information (in case of manual evaluation).

5 Conflicts of interest

None.

6 Abbreviations

HON: Health on the net

LR: Likelihood ratio

AIC: Akaike information criterion

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