Vaccine 37 (2019) 1769–1774

Contents lists available at ScienceDirect

Vaccine

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

Vaccine hesitancy and Web 2.0: Exploring how attitudes and beliefs about influenza vaccination are exchanged in online threaded user comments

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ARTICLE INFO

Article history:
Received 13 August 2018
Received in revised form 20 November 2018
Accepted 7 February 2019
Available online 27 February 2019

Keywords:
Influenza vaccine
Scraping software
Web 2.0
Vaccine hesitancy
Health communication

ABSTRACT

The growth of Web 2.0 has been particularly impactful in shaping information assessment in decision-making with regards to vaccination. The aim of the present study was to explore how attitudes and beliefs about influenza vaccination are exchanged in Web 2.0 through an analysis of user comment threads in response to related news reports on the Canadian Broadcasting Corporation national news website (average of 5.8 million unique visitors per month). User comments (n = 2042) were extracted using a Google Chrome data mining extension, from 33 articles reporting on the seasonal influenza vaccine between September 2015 and October 2016. User comments were analyzed using thematic discourse analysis to identify themes within the data, and also identify how information is exchanged, including identifying the rhetorical devices and tactics used. Mostly unrelated to article content, user comments were extremely polarized with only those with strong positions at either end of the vaccination spectrum (for or against) engaging actively in online debates. Observed exchanges, and the use of rhetorical devices and tactics employed by users are identified as furthering or reinforcing polarization. In addition to exchanging information, forums served as 'echo chambers' where individuals connect with likeminded users and collect additional information to reinforce pre-existing beliefs, rather than encouraging the enrichment of user knowledge. Our data lead us to question existing calls for public health engagement in such online forums, as doing so may actually reduce the intention to vaccinate among individuals against vaccination. Rather, we identify a greater need to observe online platforms to better understand the social mechanisms that may contribute to, or reinforce, attitudes and beliefs related to influenza vaccine refusal. Further research may also explore the effect that such dialogue has on the attitudes and beliefs of passively observing individuals who have yet to decide whether to receive the flu vaccine.

1. Introduction

The decision to vaccinate is influenced by a multitude of factors which vary across time, place, vaccine and context [1]. The notion of vaccine hesitancy directly challenges the commonly held perspective that vaccination attitudes and behaviours are a dichotomy of either accepting or rejecting, or a fixed binary (pro- vs anti-) [2,3]. Instead, vaccine hesitancy describes a continuum of attitudes and behaviours towards vaccination, wherein individuals continuously and dynamically transition across a spectrum of possibilities over their lifetime in response to a variety of influences.

Brunson and Sobo [4] et al. argue that the pathways in which individuals come to decisions regarding vaccination vary, noting that vaccination decisions are complex, socially situated, and are developed based on "diverse and dynamic multidimensional assemblages" (p. 38). In their assemblage of information, individuals draw ideas from "multiple sources using diverse criteria, held together only by connections envisioned by the individual curator" (p. 537). That is, the individual draws together multiple pieces of information in order to form a foundation upon which to choose action or inaction. Indeed, reflective vaccine decision-making requires individuals to navigate and assess multiple and conflicting

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https://doi.org/10.1016/j.vaccine.2019.02.028
0264-410X/

risks related to the vaccine-preventable disease, risks associated with vaccination, and risks associated with an individual's perceived lack of understanding [4,5]. Armed with their own personally curated information and consideration of risk, individuals are then able to engage in dialogue with others (perhaps with opposing views), and provide a subjectively informed justification for their personal attitudes and beliefs [5]. However, the reflective assessment of risk driving vaccination behaviours remains unevenly distributed [6] – for example, Brunson [7] identifies a continuum of assessment with regards to vaccination decision-making, labelling individuals as acceptors, reliers, and searchers. Acceptors are argued to simply follow the recommendations of medical professionals without any further assessment, while reliers are said to largely base their decision on the consensus of their social networks.

The growth of Web 2.0 has been particularly impactful in shaping information assessment with regards to vaccination. Web 2.0 allows users to create and upload their own original content, comment on content, and engage with each other directly through news feeds and social media websites (e.g. Facebook and Twitter) [6,7]. Witteman [8]recognizes the social nature of Web 2.0, and identifies its three defining features: user participation, openness and network effects. User participation suggests that anyone can participate and shape user perceptions and emotions through their own personal stories and testimonials. Openness implies that this 'data' is then made accessible and users can create 'new knowledge' by questioning, correcting and building upon it. The third characteristic, network effects, highlights the ability of individuals to identify, to connect and to collaborate with other users who have information, likeminded or not, that is useful for them. Network effects are said to emerge most strongly when the level of participation is sufficient to represent diversity. Web 2.0 provides the distinct advantage of interactive engagement coupled with user-tailored information, all the while providing a semblance of anonymity to the user allowing them to discuss health topics openly and without reservation. This dialogue is then made visible in users' online social networks and the new knowledge produced lives in online public spaces [8] ready to be built upon once again. Web 2.0 also provides the technology necessary to facilitate complex social interactions whereby two-way dialogue between users, based upon their respective experiences, provides user-informed 'evidence' that builds upon and reinforces existing attitudes and beliefs about vaccination and intensifies this era's "expert-doubting subjectivity" (p. 531) [6].

Web 2.0 should play a critical role in providing individuals with access to evidence-based information from trusted sources that helps them make informed choices about vaccination [8]. However, the rapid exchange and creation of knowledge via Web 2.0 affects not only information availability and credibility, but also how information is consumed, selected and deployed by individuals both in and out of cyberspace [6]. As suggested by Reich [9], individuals actively sift through information from varied sources, weigh claims, determine credibility and develop individualized strategies to guide their vaccine decision-making. They do so as 'bricoleurs' [10] (p. 27), collecting self-relevant, self-curated and context-specific fragments of information [4] in an evolving social context where objective opinions are suspect, information is everywhere and non-linear dialogue is the norm [6].

To date, there is a large body of research exploring parental hesitancy and the role of Web 2.0 in shaping childhood vaccination attitudes and beliefs [11–14]. However, very little attention has been paid to the influenza vaccine and exchanges between users in interactive Web 2.0 spaces. While often lumped with other vaccines in online debates, the influenza vaccine has a number of characteristics which are unique to those typically the focus of hesitancy research [15] including: (a) influenza vaccination is a non-scheduled annual vaccine recommended at a whole-of-population level, rather than targeting a specific demographic; (b) both the composition of the vaccine and the resulting effectiveness is variable each season since it is entirely dependent on accurate predictions of strain prevalence before the influenza season even begins; (c) a number of influenza vaccine specific myths, such as the belief that the vaccine itself can give you influenza, circulate widely; and (d) the decision to receive the influenza vaccine is very often made for oneself rather than for a child or dependent. Another important feature, which we recognize is not unique to this vaccine and vaccine preventable disease, is the general complacency about influenza [16–18]. With these specificities in mind, the influenza vaccine provides an interesting case to that of parental hesitancy and childhood vaccinations.

Our aim in the present paper is to build on what we know regarding vaccine decision-making, and explore how attitudes and beliefs about the influenza vaccine are exchanged in Web 2.0. We accomplish this aim through an analysis of user comment threads in response to influenza vaccination related news reports published on the Canadian Broadcasting Company (CBC) website between September 2015 and October 2016.

2. Methods

Our exploratory approach involved collecting and analyzing two forms of data, news articles and related threaded comments using thematic and discourse analysis respectively. Since discourses are conversations with an agenda that are oriented towards action, the knowledge produced within such discourse functions to influence how individuals make sense of their experiences [19]. As such, the advantage of this method for the present analysis is that beyond identifying themes within data; it also allowed us to identify how the language and tactics used by commenters create meaning which underpins the themes articulated in the comment threads [20]. News articles and comment threads were freely available and published digitally by Canada's largest national public broadcaster, the CBC, that welcomes an average of 5.8 million unique visitors per month [21]. The commenting feature on the site is a threaded format which allow users to not only reply to original posts (OP), but also to reply to the threaded replies (TR) under the OP. In addition, all TRs are indented under the OP and the atmark (@) identifies the specific comment a user is replying to in a given thread.

3. Data collection and analysis

3.1. Article selection

A systematic search of news reports available on the CBC national news website was conducted. Search terms included "influenza", "vaccine", "vaccination", "immunization" as well as "flu", "flu shot" to reflect the manner in which popular media often refers to influenza. SBM and RA independently screened articles by title and full-text for inclusion. News articles were included if they were a text-based news report, published between September 2015 and October 2016 (roughly one influenza season) and mentioned the influenza vaccine either as a product (i.e. the vaccine) or service (i.e. vaccination clinics). News articles were excluded if they referred only to alternative forms of the vaccine (i.e. flumist), dealt strictly with influenza as a disease (i.e. hospitalizations), or were in a format other than text (i.e. audio, video or blog format). The internal CBC link section of included articles was also manually searched to ensure that no articles were missed in the electronic archive search. There were no disagreements between reviewers on article selection. Selected articles were reviewed

independently and notes were taken regarding article content and messaging. A coding framework was developed collaboratively and all articles were coded for tone and content allowing user comments to be contextualized as they relate to the news articles.

3.2. Comment thread extraction

User comments were extracted using Scraper v.1.7 [22], a Google Chrome data mining extension to automate the data extraction process. Limits inherent to the website's application programming interface (API) prevented the collection of any personal or identifying information. As such, we were unable to conduct analyses as they relate to demographic and user characteristics. Three independent reviewers (SBM, MS, RV) coded 100 user comments inductively for content and rhetorical tactics to develop the preliminary coding framework. Coding was then reviewed by the team and the framework was refined based on consensus. Reviewer MS coded the remaining data using the framework, and consulted with the team to discuss the emergence of additional themes and devices. The framework was iteratively refined throughout the analysis. RV subsequently reviewed and reanalyzed the data in line with the aim of the existing manuscript, specifically focusing on engagement between users and the use of rhetorical devices and tactics.

3.3. Ethics

In consultation with Research Ethics at the < *removed for blind peer review*>, it was determined that ethics approval was not required. The data collected are publicly available user comments, on publicly available news reports, which are themselves posted on a publicly available website with uncontrolled access. CBC Terms of Use also specify that there can be no reasonable expectation of privacy when posting user comments on the CBC website since every post is linked back to the publicly accessible profile of the user [23].

4. Results

4.1. Description of included articles

The search strategy identified >1200 articles of which n = 64 met the inclusion criteria. More than half of the articles (n = 33) discussed immunization as a service, n = 18 (28%) discussed the vaccine as a product and 20% (n = 13) discussed immunization both as a product and a service. Broadly, the articles tended to be promotional in nature, providing information regarding the seasonal availability of the influenza vaccine and reporting on vaccination recommendations. Very few risk messages related to getting the vaccine were present in the included articles.

4.2. Description of user comments, unique usernames and participation

Broadly, comment threads under the included articles largely deviated from article content, instead serving as a forum to exchange information about vaccines and immunization more broadly. User comments were highly polarized and comment threads became the virtual forum for discussion about vaccines as a product, essentially ignoring the services heavily featured in the articles.

Of the 64 articles included, less than half of the articles (n = 33) were open to user comments. Despite our inquiry to the CBC, we were unable to determine why certain titles were open to user comments while others were not. In total, n = 2042 user comments were extracted for analysis. Of these, n = 480 were original posts (OP), with 57% (n = 270) of the OPs generating n = 1562 threaded responses (TR) in the dataset. Within the TRs, an equal proportion were directed at the initial comment (49.4%) as were responses to other TRs (50.6%).

Post-hoc analyses across all comment threads identified n = 592 unique usernames, with n = 85 additional posts (n = 9 comments, n = 76 responses) for which user identification was not possible. While it is entirely possible for users to sockpuppet (i.e. register more than one username using multiple emails), it was not possible to verify since the software did not scrape IP info. Of these, n = 381 (+9 missing) unique usernames posted OPs, n = 371 (+76 missing) unique usernames posted TRs, and n = 159 identifiable usernames posted both OPs and TRs. Moreover, participation of unique users was generally concentrated under the same article with very few unique usernames participating across multiple articles despite the convergence of topics.

Due to recent reports of the proliferation of Twitter Bots and Russian trolls in online vaccine debates [24], efforts were made to detect their presence. One major instance of double posting was detected where a single user re-posted the same list of 9 vaccine critical web links as a contained response 22 separate times within the same comment thread on the same article. While double posting is often an indication of bot participation, or a method for trolling and spamming a thread, it was not clear whether this was either the case or the intention of the user.

4.3. User comments: tactics and polarized views

The influenza vaccine: Is it an exception?

In many cases, individuals who were supportive of vaccination generally, were unsupportive of the influenza vaccine or were supportive but still chose not to get the vaccine. By those opposed, the influenza vaccine was described as unnecessary, unreliable, a joke, or a scam compared to other vaccines that have provided great advancements in preventing communicable disease (i.e polio). "*Don't get me wrong, I'm all for vaccinations against serious diseases. They work. But I'm skipping the flu shot from now on*". The most common arguments driving this position were the variable efficacy of the vaccine, the vested interests and profits of 'Big Pharma' and governments in advocating this vaccination every year, and general complacency about influenza as a serious disease.

I am not antivax, but...

Many individuals, in addition to stating that they did not support influenza vaccination, also went to great lengths to distance themselves from being identified as an 'anti-vaxxer'. For example, "*One can be *highly* critical of the flu shot industry without being lumped in with the loony 'antivax' nutters.*", *"I am not an anti-Vaxer but I am anti-Flu-Vaccine*", and *"No I am not anti-vax but I am certainly not a vax lemming either*". The notion that these individuals do not want to be associated with 'anti-vaxxers', despite their position against the influenza vaccine, may be related to the increasingly negative perceptions of anti-vaxxers by both the media and by the general public. Most striking are comments which attempt to reframe the anti-vaxx movement from an 'anti' to a 'pro' position, such as *"we are not Anti-Vax, we are PRO-HEALTH*".

Building a case for or against influenza vaccination: Dialogue, tactics and escalating polarity

Broadly, user participation in the CBC news comment section is extremely polarized and conforms strongly to the reductive binary understanding of accept or reject. The binary is so pervasive in threaded comments that some users actively reminded other users to explicitly position themselves on either side of the debate, *"Remember, you are either FOR all vaccines OR you are AGAINST all vaccines!*".

Many users initiated dialogue with other commenters – often between individuals or groups of individuals with competing positions.

TR: my god, you are the ignorant one if you think a concoction of chemicals is going to protect you, it's too bad you believe everything that MSM regurgitates: http://www.naturalnews.com/053171_flu_vaccine_healthcare_workers_mandatory_immunizations.html.
TR: Here we go with 'naturalnews'. Didn't take long to start with the anti-vaxxers websites. Never mind scientific studies- drop it Dalhousie, you can get your information from 'natural news' (and Mercola, and Andrew Wakefield!)

Likeminded users also engaged with one another to form arguments for their position, or against the opposing position – using mutually supportive comments to build their case.

TR: Did you learn that in med school or while getting your masters in immunology?
TR: I am sure he has watched a couple of youtube videos. That has to count.

This was also seen in dialogue between opposing views, whereby one group built a collective case with input from multiple likeminded users to combat an opposing perspective.

TR: My point exactly. Science could learn about tolerance and open-arms if it read some reports published by the house of God
TR: Thats weird since there is no God
TR: Only self-elite cliques that form around religious identity.
TR: I think pastor Dan isn't a scientist and won't ever be contributing much to vaccine research.
TR: science isn't based on tolerance, it's based on evidence, something the house of God isn't all that fond of tolerating.

As shown in the examples above and within the larger dataset, both vaccine promotors and refusers employed various tactics in different ways to initiate and build dialogue with other users. For example, ridicule was largely used as a form of allied communication between likeminded users, but also in response to opposing viewpoints. Sarcasm was another common tactic, often used to question the sources of information used by individuals to inform their attitudes and beliefs. These tactics were deployed more frequently in the TRs rather than in OPs and were most often used in support of, or as a counter-response to, a similar tactic from another user. For example, when users employed sarcasm or ridicule in their comments, the response was usually one of sarcasm or ridicule. However, these threads devolved very quickly and tended to stop abruptly once there was no more room for additional ridicule or sarcasm.

OP: I like mercury and get my recommended daily allowance via the flu shot.
TR: Plenty of foods have mercury, too. You probably consume more that way, but hey, if you prefer having the flu...to each their own.
TR: What, you don't eat tuna?
TR: No he doesn't eat the flu vaccine.
TR: There's sodium in your salt, and on your skin, but you don't explode into flames when it rains, do you?

Table 1
Examples of the most commonly employed rhetorical devices and tactics in CBC.ca threaded comments, ranked.

Rank	Device or tactic	Examples from the data
1	Sarcasm	*Sit down, you won't believe this. There are many researchers, working from different places, on different questions, and coming up with evidence and doing peer-review of other researchers. I KNOW!! How wacky is that? Surely it would be more efficient to just have one researcher, right? :P* *We're talking about flu shots, not polio vaccinations. But sure, just go ahead and take whatever is on offer, no need to apply any critical thinking to make informed choices on your own healthcare. It's not like anybody is in the pharmaceutical industry to make money on you, right?* *I just ran into a guy on the subway who pointed out that, according to his research (and the ancient pyramidic scrolls); there has been no Ebola or Zika viral outbreaks, and it is all a big scam so that Big Pharma can invent new vaccines and force us to take them. (The pictures were all faked- like the moon landing shots) So you can all relax now, because Subway Guy has no reason to lie to me.*
2	Correcting misinformation	*That is simply not true. Please stop spreading misinformation. Washing hands is great, but it is certainly not a cure all for influenza. The best defense against spread of the flu is immunization. No other measure even comes close.* *You had the flu before you got the vaccine. Flu vaccines do not give you flu.* *That's not how vaccines work.*
3	Anecdote	*I've had full-blown influenza once and I never want to feel like that again. It's not at all the same as a bad cold; it's systemic and just plain nasty. That was 20 years ago and I've had my annual flu shot ever since.* *Following my last flu shot vaccination in 2011, I was disabled and remain disabled. I do not trust doctors in Canada, nor do I believe vaccinations are safe and effective...* *I know someone crippled by polio as a child - and believe me they know as we do that vaccines do work*
4	Ridicule	*Cue the big pharma hipsters and soccer mommies who think they know more then doctors and scientists. I wish i had the time in my life to be paranoid that everything is out to get me and is evil.* *I'd say your knowledge of immunology is on par with your knowledge of grammar and spelling.*
5	Use of evidence	*Well, the increase in influenza antibodies is an established fact. It's the basic principle for how vaccines work, with scientific research going back decades. Our immune system's response to the seasonal flu shot actually looks better than ever. Inoculations for new strains of flu actually boost our immunity to strains we already have antibodies for. Our bodies make antibodies for the new shot and boost the antibodies we already had for the older flu strains. Very neat!* *So we've got conclusive results based on close to a quarter of a million children over a decade. And a Canadian study that independently reached similar conclusions.* *Not only is the flu vaccine not a magical 100% barrier to transmitting the flu to vulnerable patient's, there is evidence that receiving the recent ineffective vaccines makes individuals more vulnerable to mutated strains of the flu.*
6	Request for proof	*Can you cite your sources on that? Providing a statement like that without providing the proof is nothing more than fear mongering.* *Hundreds? A link to you proof, please?* *Source? Evidence? Any proof of this?* *Ginseng, ginger, lemon tea.....can anyone point to any reputable research that shows that these have any healing benefits?*
7	Analogy	*If you had a 50% chance of winning the lottery, would you refuse to buy a ticket because of the equal possibility you won't win?* *No..it's magic thinking. Like the people who drive drunk, text while driving etc etc. It'll never happen to me...it'll happen to someone else.*
8	Knowledge deficit	*More 'aluminum' in a pickle than a dose of flu vaccine. Do you know 'aluminum' (sulfate) is used in water purification systems? So much scaremongering with the word "mercury" and "aluminum" due to the level of ignorance about basic chemistry which sadly seems to go hand in glove with the antivaxx mindset*

TR: Do you know the difference from Injection versus ingestion. . .big difference. . .but you can beLIEve what ever you choose..none for me thanks

Both vaccine rejecters and promoters used many other tactics to support their positions, with varying frequency (see Table 1). For example, many users called into question the perceived knowledge deficit of their counterpart and attempted to correct misinformation by offering various sources of 'evidence' to refute counter arguments and support their own attitudes and beliefs. This 'evidence' took many forms ranging from personal anecdotes and analogies, to web links and other sources of published statistics. The use of web links was most often used by vaccine refusers, which could be due to the wide availability of anti-vaccine resources on the internet. Inversely, peer-reviewed science was infrequently cited by vaccine promotors. Usually behind pay walls, peer-reviewed literature is harder to access and often beyond the average person's scientific literacy level.

The language present in comments is also powerful. Vaccine refusers tended to adopt accessible language free of numerical metrics to discuss the prevalence of what are assumed to be potential side effects of vaccines – for example, using terms like 'skyrocketing' (rather than figures), and definitive language suggesting vaccines cause multiple medical conditions. Vaccine promotors were quick to respond with counter arguments, often questioning the sources used to form arguments around causation and citing statistics or other forms of official data, using tactics and devices noted above. However, the use of these tactics proved to be counter-productive. We did not identify any indications of changing beliefs on either side through their use; rather, their use appeared to widen the divide.

5. Discussion

The aim of the present research was to explore how attitudes and beliefs about influenza vaccination are exchanged in Web 2.0. Our approach lends itself to novel insight regarding the increasing importance of threaded user comments as indicators of public opinions around vaccination. The participation of users on Web 2.0 platforms provides rich data that allows us to explore individual opinions and to identify the extent to which consumers engage with one another to 'assemble' the knowledge base that informs their vaccination decisions.

CBC and perhaps other similar user comment platforms appear to generate a more diverse user base, albeit polarized, than other platforms such as Facebook, where users opt to join or subscribe to pages with users who hold similar attitudes and belief systems. The dialogue within our dataset suggests that rather than assessment, critical reflection and an opportunity to retain new information, such forums tend to foster further polarization among users. Indeed, the observed exchanges, engagement and tactics employed appear to further the divide, rather than encourage the enrichment of user 'assemblages'. Users may be, perhaps consciously or otherwise, using such forums as a site to reconfirm and reinforce their existing stance on vaccination rather than to consider opposing viewpoints. As such, these users might be viewed as beyond the 'assessment' stage [7], engaging in forums to promote their position, and assembling further evidence to strengthen their existing beliefs. In other words, these forums also served as 'echo chambers' for individuals to connect with likeminded individuals and collect additional information to reinforce their pre-existing beliefs [25,26]. Indeed, it has been suggested that those holding anti-vax positions engage with Web 2.0 to mobilize and consolidate their objections in order to strengthen their anti-vaccination stance [27,28]. Our findings therefore lead us to question existing calls for public health engagement in such online forums [8]. Providing counter information in support of vaccination in this context seems to be counterproductive, and may actually reduce the intention to vaccinate among individuals against vaccination [27]. Rather than respond and engage in the promotion of information online, our data identify a greater need to observe online platforms to better understand the social mechanisms that may contribute to, or reinforce, attitudes and beliefs related to influenza vaccine refusal [28].

The nature of the user comment space provided dialogue through which we could explore the devices and tactics used by both sides. As noted, both vaccine rejecters and promoters used many tactics to support their positions. The use of such devices by promotors is unsurprising given that mockery of anti-vaxx sentiment is perhaps becoming more salient in society than ever before, as greater efforts are made to debunk myths and highlight instead the dangers of choosing not to vaccinate despite the evidence base. Some of the commenters, for example, made a point of clarifying that despite not receiving the influenza vaccine, they are not anti-vaccination, suggesting negative connotations associated with this label. Certainly the Canadian media have been observed to paint individuals who do not vaccinate as irresponsible and uninformed [29]. Parents who choose not to vaccinate often experience judgement from friends and family, vaccinating parents and some healthcare professionals [5,30]. Judgment, and therefore likely ridicule and sarcasm, has not been found to positively influence vaccination uptake; rather, it may have negative implications for social relationships as well as use of healthcare services [5]. Our data supports this and clearly suggests that using such tactics to promote the influenza vaccine may in fact intensify polarization.

The extreme polarization of positions within the online space we explored has important consequences as it essentially dissolves any space for the opinions of individuals between the two extreme end-points of the vaccine hesitancy continuum. Individuals who fall along the vaccine hesitancy continuum are more likely to be spectators or lurkers in these debates [31,32]. These individuals passively consume the information, arguments and evidence being presented. Existing research suggests that the pervasiveness of anti-vaccination content on the internet, and the negative and false information around vaccinations online and in social media fuels vaccine hesitancy and influences vaccination decisions [13,33,34]. Research has suggested that individuals who read balanced articles presenting conflicting views regarding vaccination safety may lead readers to incorrectly infer the state of expert knowledge regarding vaccine safety and negatively impact vaccine intentions [35]. However, the manner in which users determine the credibility of other online users and the information they share in these spaces, and the extent to which it informs the development of, or reinforces hesitancy, remains unresolved. Our analysis does not lend itself to identify how, or if these individuals are influenced by observing online dialogue. Future research should explore how non-participatory engagement in Web 2.0 spaces influences attitudes and beliefs in individuals who have not yet decided whether to receive the influenza vaccine.

5.1. Limitations

CBC is a Canadian website that attracts specific readership who choose to access news in an online format. Our analysis would be more nuanced if we were able to obtain demographic information and explore user characteristics in the context of online participation. In addition, our sample of user comments is limited to one single influenza season. Future studies should consider repeating similar analyses using national and international online news

sources and collect user comments longitudinally to identify how cultural and contextual factors shape the nature of this dialogue.

6. Conclusion

Our work advances scholarship relating to how attitudes and beliefs about influenza vaccination are exchanged in Web 2.0. We provide further empirical support to the notion that social settings, in our case Web 2.0, can serve as "incubators" or "crucibles", intensifying values regarding vaccination [28] (p. 396), and fostering further polarization rather than encouraging consideration of opposing views. However, further research is required to identify the extent to which attitudes and beliefs are reinforced for those participating, as well as the effect that such dialogue has on the attitudes and beliefs of passive consumers of these exchanges who have yet to decide whether or not to receive the flu vaccine.

7. Declarations of conflict of interest

None.

8. Submission declaration and verification

The work described has not been published previously and is not under consideration for publication elsewhere.

9. Contributors

SBM and RV developed the research question and research design in consultation with NW and HM. SBM, RV, MS and RA collected and analyzed the data. All authors contributed to the discussion and writing of the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2019.02.028.

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