ONLINE MISINFORMATION ABOUT VACCINES*

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INTRODUCTION

"Vaccine hesitancy" was one of 2019's 10 most notable threats to global health, according to the World Health Organization ([WHO], 2019a). With high-profile measles outbreaks in Brooklyn, Samoa, the Democratic Republic of the Congo, and Italy; misinformation impacting the polio eradication program in Pakistan (Bhattacharjee & Dotto, 2019); and a controversial rollout of Dengvaxia in the Philippines (Mason & Smith, 2020), vaccine-related headlines have become a feature of contemporary life.

The main reasons people do not vaccinate their children when vaccines and vaccination services are otherwise available include cost; convenience; moral, philosophical, or religious objections; or lack of information about when and how to obtain vaccinations. More

* This article has been updated to reflect evolving developments since the September 2019 meeting of the Sabin-Aspen Vaccine Science & Policy Group. An earlier draft of this paper informed the group's in-person discussion. While the conclusions have not changed substantially, some more recent trends are also included here.

troublesome is the misinformation that has infiltrated the conversation about vaccinations online and via social media. For example, people express doubts about the undue influence that "big pharma" plays in vaccination efforts (Lyman, 2019); there is the belief that "the West" uses vaccines for population control in other countries (College of Physicians of Philadelphia, 2020a); and parents are still impacted by the ongoing "zombie rumor" that the measles, mumps, and rubella (MMR) vaccine causes autism, which is based on discredited research published in 1998 by Andrew Wakefield. Other concerns are country- or region-specific. For example, there are ongoing questions in Pakistan about "Western influence" (Robbins, 2011) which arose after CIA operatives posed as UNICEF vaccination workers to obtain DNA samples from Osama bin Laden's family.

All of this creates the backdrop for vaccine conversations between individuals and on public forums that can be based on misleading and false conspiracy theories and rumors, whether they sit in Google search results, YouTube videos, or Facebook, Instagram, or WhatsApp messages. A study published in February 2020 demonstrated that people exposed to vaccine content on social media were more likely to be misinformed than those exposed to it on traditional media. The study, based on a nationally representative survey of nearly 2,500 U.S. adults, found that up to 20% of respondents were at least somewhat misinformed about vaccines and that "people who received their information from traditional media were less likely to endorse common anti-vaccination claims" (Stecula, Kuru, & Jamieson, 2020).

The focus of initiatives to address misinformation and disinformation online over the past few years has largely been on the integrity of elections. But more recently, health and science misinformation—particularly related to climate, food safety, vaccines, dangerous alternative "cures," manipulative cancer quackery, and misinformation about the new coronavirus (COVID-19)—have attracted interest as well. As concerns have been raised about the impact of social media on vaccine decision-making, social media platforms have been rolling out new initiatives, including advisories (Twitter) and removing certain anti-vaccination content from search results (Pinterest) and recommendation engines (YouTube; Seyoum, 2019). Experiments around election interference have demonstrated that comprehensive real-time

monitoring of social spaces; rapid response policies such as downranking and removing problematic and harmful content; and well-timed and carefully designed debunking can help slow down false or misleading information. There are clear lessons to be learned and applied to tackling the challenges posed by the online anti-vaccine movement.

GLOBAL LANDSCAPE OF ONLINE MISINFORMATION

Online anti-vaccine messages are also becoming an increasing problem in other countries, resulting in less trust in vaccinations during the yellow fever outbreak in Brazil (Kaiser, 2018), rising levels of misinformation circulating on WhatsApp in India (Purnell, 2019), sudden panic around polio vaccinations in Pakistan (Bhattacharjee & Dotto, 2019), fuel for ongoing conspiracies around Dengvaxia in the Philippines (Mason & Smith, 2020), and an apparent impact on large measles outbreaks in the Democratic Republic of the Congo (BBC News, 2019a) and Samoa (Gerson, 2019).

A study of online vaccine misinformation in Brazil—a country with a very robust national vaccination program—shows that a downward trend in the number of people getting vaccinations began around 2015 (Zorzetto, 2018). The study indicated that 8% of Brazilians found vaccines "partially unsafe" and 72% had seen negative news about vaccines on social media or messaging apps. Another 6% said they found vaccines "totally unsafe" and 59% had seen negative news about vaccines on social media or messaging apps (Avaaz, 2019). While this survey cannot disentangle causality, the percentage of people reporting that they had seen negative information about vaccines on social media is an important data point.

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CHALLENGES OF STUDYING MISINFORMATION

It is almost impossible to answer questions about the prevalence of online misinformation and its impact on people's beliefs and behaviors without access to the data locked in individual platforms. The process of sharing this data has been complicated by the challenge of building databases based on differential privacy that would protect users' identities. In February 2020, however, Facebook finally released the largest-ever dataset of URLs that have been shared over 100 times (over an exabyte of data; King & Persily, 2020), allowing researchers to better study the flow of misinformation on Facebook. Scholars hope this might lead other platforms to release data so that researchers can better understand how misinformation is shared and consumed.

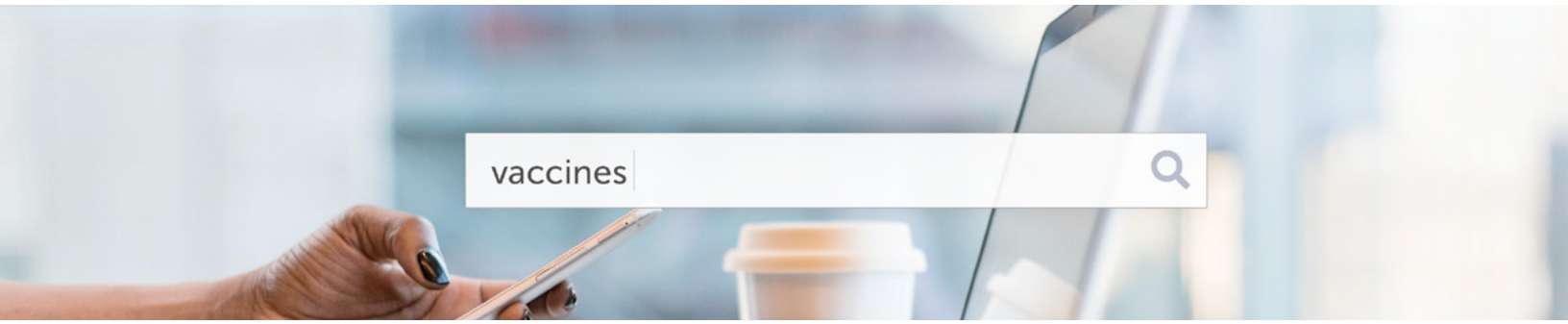
While the release of this dataset is a positive development, it focuses exclusively on URLs (as does much of the research around misinformation since 2016). However, much of the potentially harmful content does not sit exclusively on websites, but in Facebook posts, Instagram memes, misleading tweets, and conspiratorial YouTube videos. Without access to this data, measuring the full scale and impact of this type of content is impossible.

In April 2019, Claire Wardle (a co-author of this paper) and Alexios Mantzarlis used a new method to understand prevalence. They asked people in 12 countries (including Australia, Brazil, Egypt, India, Nigeria, and the Philippines) to perform two tasks (Wardle & Mantzarlis, unpublished, 2019).

1. ***Enter the query they would use on a search engine to find information related to vaccines online*** **(Figure 1).**

The results in English are shown to the right (note that the wording is reproduced as it appeared on the search string, underscoring the challenges related to identifying misinformation):

Figure 1. Query results for vaccines search (English)



How safe are vaccines • Vaccines Australia info • Vaccines immunisation • Immunisation Australia • child vacines guide • vaccination for kids, safety and regulations • Vaccines safe • Child vaccination safe to use • Children vaccines and its safety • Vaccinating your child • Vaccination • Pros and cons of vaccanating • Vaccinations in early childhood • vaccines in children side effects safety • are children's vaccinations safe • Pros of vaccines or dangers of not vaccinating children • vaccines for children Australian government • is it safe to vaccinate a child • are vaccines harmful • Child vaccinations Adelaide • Vaccinations for children and safety • Evidence from credible sources that child vaccination is safe • Vaccine safe • is vaccination safe for children? • Child Safety and Vaccines • information about child vaccines • Information on vaccines for newborn babies • child vaccination schedule • Vaccination for child. • top child vaccines manufecturing brand in the world • Is vaccination dangerous for child? • Vaccine for new born in India • vaccines and child safety • Vaccine and Immunization centres for new born India • How to safe from vaccines of a child • Child vaccination precaution • vaccine information to be administered age wise • Child safety • VACCINATION FOR INFANTS • name of vaccines safe for child • Vaccines Centre • How do I know if it is safe to vaccinate a child • is it safe to vaccinate child • Are Vaccines safe for Infants/ Children? • WHAT ARE THE BEST VACCINES AND CHILD SAFETY GUIDELINES • Tetnus • Health vaccines information • vaccines and child safety • vaccination for new born baby • is it good for a newborn baby to be vaccinated • baby care instruction • vaccines and their advantages • Vaccines for new born baby • child vaccines • Are child vaccines safe? • Is it safe to vaccinate your child? • How to vaccines children 2019 • Is getting your child vaccinated best • Is it safe to vaccinate my child • vaccines child safety • Should I vaccinate my child • Are travel vaccines safe for children • Vaccines information for kids • Safe vaccines for children • vaccines for kids • Child vaccinations • vaccines debunked • Vaccination children • 111 or mums net • Safety of vaccinations • vaccines and child safety • Vaccination safety • Vaccines on kids • vaccines for children • is it safe to use this certian vaccination • what are recommendations for vaccinating children? • safe or not to vaccinate children uk • Nhs safe

Some of the search queries in different languages are shown here:

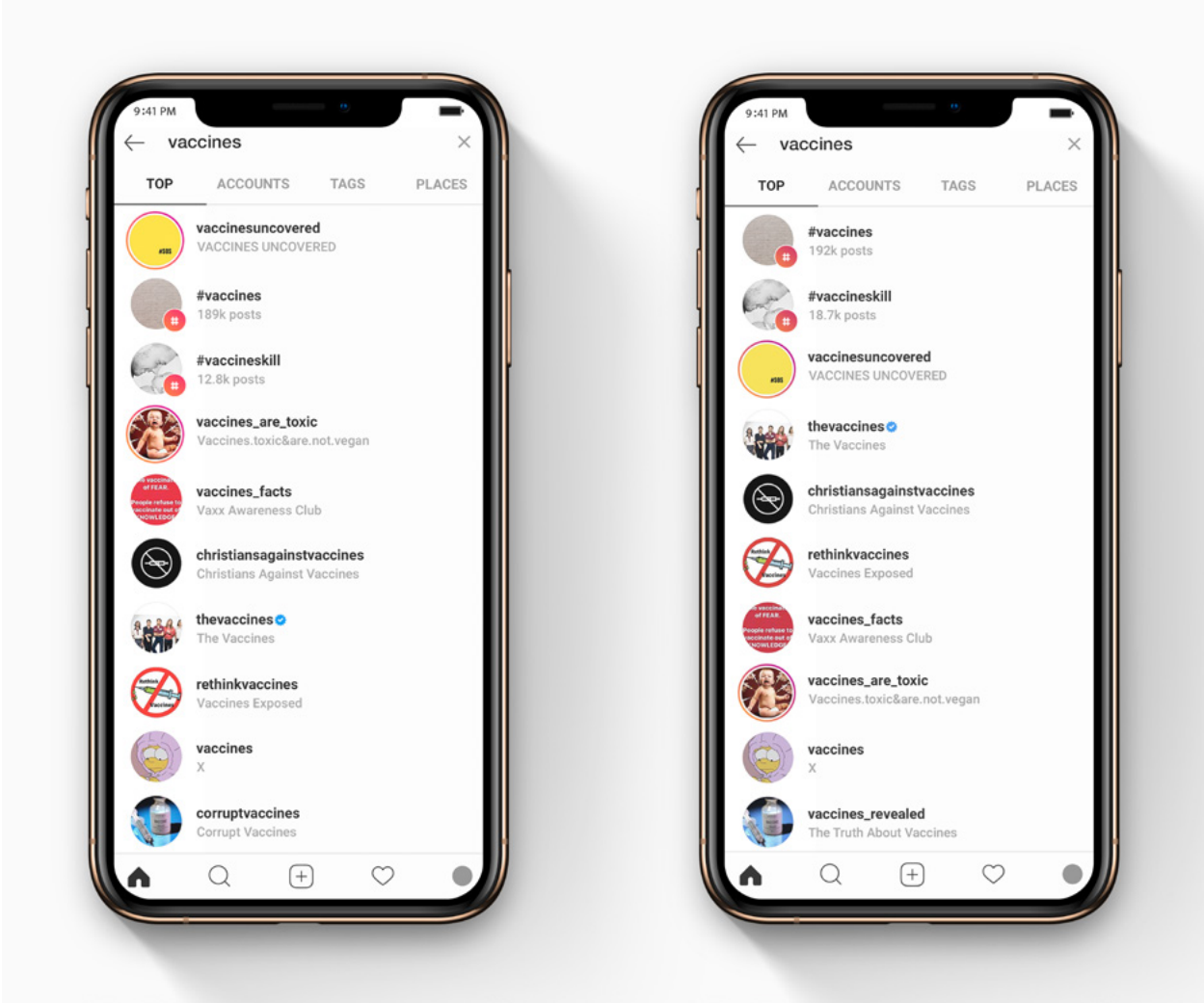
Figure 2. Query results for vaccines search (different languages)

Vacinação em crianças é seguro? • O nome da vacina • vacina para... por exemplo "vacina anti-tetânica" • vacinas para cranças • Informações seguras sobre vacinas • "vacinas" + "segurança infantil" • Vacinas para crianças • Vacinar é seguro ou não? • Vacinar crianças é realmente importante para a saúde delas? • vacina em criança é seguro • quais as vacinas infantil necessárias? Elas são confiáveis? • Como identificar vacinas infantil seguras • Para que serve a vacinação • vacina recem nascido • quais as vacinas que devem ser tomadas por bebês • vacinas para crianças • seguro vacinar crianças? • É seguro vacinar crianças? O que devo fazer? Onde posso encontrar e quem deve fazer essa vacinação? • Se o remédio ou vacina faz algum mal para a criança • quais as vacinas disponíveis para uma criança tomar quais são os efeitos colaterais • efeitos adversos vacinação infantil • queria busca infomacoa sobre vacinas • vacinas segurança • Vacinas para criança doente • vacinas infantis • Pesquisaria, no google ou yahoo sobre o sintomas do meu filho • Vacinas importantes para crianças • vacinas são seguras para crianças, o que acontece se elas não forem vacinadas • É seguro vacinar crianças? • com quantos meses eu posso vacinar o meu filho? • Vacinação para crianças é seguro? • Vacinas são seguras? • qual medicamento tomar para gripe • Vacinas prós e contras • Vacinação para crianças é segura? • Vacinas infantis • é seguro tomar vacinas ? • Qual vacina de segurança infantil escolher para seu filho tomar? • Segurança para vacina infantil • o nome da vacina e as recomendações • vacinação riscos • Procuraria saber o tipo da doença que a criança apresenta, e procuraria saber o tipo de vacina mais indicada pra ela, incluindo a faixa etária pra idade dela, e tomando cuidado com os possíveis efeitos colaterais. • مايخص لقاح وتطعيم الاطفال • خطورة اللقاحات بالنسبة للأطفال • لقاحات وامان الاطفال • لقاحات الاطفال المنه • كيفيه اللقاح • معلومات عن اللقاحات • ملف لقاحات الاطفال • التلقيح و الاطفال • لقاحات الاطفال بالتفصيل • اللقاحات المنة للاطفا • Vaccins enfants • vaccins risques • sécurité vaccins • les vaccins et la sécurité des enfants • Vaccination enfants ou la vaccination des enfants est elle sécurisé • risque liée à la vaccination • vaccin et sécurité

The findings are a reminder of the challenges that search and social media companies face. The range of search strings makes it especially difficult to ensure quality search results on every possible search string. Research by Michael Golebiewski and danah boyd (2019) on data voids explores these challenges in greater depth.

2. ***Search specifically for the search string "should I vaccinate my child" on Google, YouTube, and Facebook, and for #vaccines on Instagram, and then supply screenshots of the results*** **(Figure 3).**

Figure 3. Screenshots from Instagram submitted from participants in the United States (left) and India (right)



There was very little localization of high-quality sources of vaccination information in search results. While Google highlighted the Centers for Disease Control and Prevention (CDC) in the United States and the National Health Service (NHS) in the United Kingdom, there was a lot of focus on the CDC and the WHO globally. More recently, there appears to be a greater awareness of local sites, probably because of partnerships with the Vaccine Safety Net (a global network of websites established by the WHO that helps validate quality vaccine information providers online; WHO, 2019b). For example, in Brazil, if you click on "anti-vaccination groups," a pop-up message at the top of the group reads in Portuguese, "This group discusses vaccines." The warning goes on to encourage people to seek out quality sources of information and provides a link to the Brazilian Ministry of Health.

These findings were not published because the technology companies all made public changes to their vaccine policies around the same time and it appeared these policy changes would significantly impact the search results. The methodology bears replication though, because without this kind of screenshot auditing, it is impossible to know just how people search and what people in different countries actually see in their search results. (As an aside, the variation in results was extremely small with almost no evidence of personalized results.)

> The response of these platforms to COVID-19 also suggests a much more aggressive position toward health misinformation online.

Since this research was conducted, the major social media platforms have updated their policies around vaccines and misinformation, amending their ranking and curation policies to take into account a range of criteria (discussed in more detail below) and partnering with international health authorities (WHO, 2019c). The response of these platforms to COVID-19 also suggests a much more aggressive position toward health misinformation online. The question remains whether similar steps will be taken to counter vaccine misinformation.

While some of the steps over the past 12 months are promising, recent reporting demonstrates that real concerns still exist about whether these promised changes to vaccine-related policies are having the desired effect. For example, Jesslyn Cook reported in the *Huffington Post* in February 2020, almost a year after new policies were rolled out across Facebook products, that a search for the term "vaccines" on Instagram produced top results that were disproportionately pushing anti-vaccination positions. Perhaps more troubling, the reporter explained how Instagram then recommended dozens more anti-vaccination Instagram accounts that users could follow (Cook, 2020). Another report by Brandy Zadrozny at NBC discussed the impact of anti-vaccination Facebook groups that convinced a mother not to give her son Tamiflu, and whose son subsequently died (Zadrozny, 2020).

Personal Experience as Evidence

The 2018 Wellcome Global Monitor demonstrated that there is still high overall global trust in doctors, nurses, and scientists and confidence in vaccines (Wellcome Global Monitor, 2019). However, there are stark differences around the world. Almost all survey respondents in Bangladesh (98%), for example, believe vaccines are both safe and effective. But in France, one-third of people don't think vaccines are safe, while in Ukraine only 50% of the population think vaccines work. Some countries, like Brazil, that have had very successful national immunization programs are now reporting declining vaccination rates (Sato, 2018).

However, expert "gatekeepers" no longer control information flows because of the presence and popularity of social media. As a result, some people, such as new mothers, are balancing expert advice from their medical practitioners with the personal experiences they see shared on Facebook groups, even by people they know only through their online presence. Exemplification theory exposes the ways in which humans group and compare different but similar "experiences" and, as a result, can over-index on their perceptions of risk (Zillmann & Brosius, 2000). While more research is needed, Facebook groups where people share first-person experiences of supposed vaccine side-effects can potentially have a disproportionate impact on parents trying to assess the risk of vaccinating their child.

These personal experiences, illustrated with upsetting images of babies covered in rashes shortly after being vaccinated, are juxtaposed against scientific, peer-reviewed evidence—with anti-vaccination mothers claiming that the real evidence is revealed in the vivid images that accompany these claims. Anecdotes are used as evidence on both sides, as Shelby and Ernst (2013) and Shermer (2008) document. Emotion is the currency of social media networks because facts are rarely as engaging, unless they are packaged in incredibly appealing ways.

Another ongoing theme in the anti-vaccination community is that its members are the ones with all the facts (Figure 4). The communities of anti-vaccine advocates share a sense of being more informed than those who support and promote vaccinations. The dominant narrative is that they are the only ones who have done sufficient research on the impact of vaccination and that the "real" story is being kept from the people by complicit media and institutions. For example, mothers holding "binders of evidence" has become a common meme.

Figure 4. Instagram post implying that only those who have done their "research" have all the facts

Poor Online Content from Professional, Credible Sources: Getting in the Game

Unfortunately, those with professional health expertise are not often experts in generating engaging, dynamic content designed to touch people's emotions. Experts in these spaces are typically academics, scientists, and professionals—at international organizations such as the WHO, the CDC, and UNICEF, and in academia—who excel at creating official reports and peer-reviewed science, not compelling Instagram memes. The absence of visual imagery and videos in much of their work is a particular challenge, given the popularity of YouTube and Instagram (the second and sixth most popular platforms globally, respectively), and the increasing popularity of the online video platform TikTok (now the seventh most popular platform globally) (Kemp, 2020).

In addition, many national health authorities have very poor websites that lack visual content, if they have a website at all. As a result, social media and search companies have to rely on limited sources of authoritative content globally. These authorities are also challenged by each population's differing levels of trust. In some countries, for example, the WHO is trusted more than the local health authority, while in others, the opposite is the case.

In contrast, those who oppose vaccinations are very well organized. In addition to the large national anti-vaccine communities that exist within Facebook groups, there are Facebook pages for "vaccine freedom" legislative advocacy organizations in nearly every state in the United States. And this isn't just a U.S. problem. For example, during the measles outbreak in Samoa in November 2019, a local influencer described the government's mass vaccination program as a crime against the Samoan people. Communicating largely through Facebook, this individual not only criticized vaccines but also promoted ineffective remedies, such as papaya leaf extract and Vitamin C, to cure children with measles (BBC News, 2019b).

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The reach of media extends beyond national borders as anti-vaccination activists from around the world, and particularly from the United States, also target other countries. This was the case in Samoa, where U.S. anti-vaccination activists were leaving one-star reviews on the official Samoan government Facebook page ("Measles deaths," 2019). The same pattern was observed in Brazil, where a study by the Brazilian Society of Immunizations and Avaaz (a nonprofit human rights activist network) showed that a single U.S. anti-vaccination website, Natural News, accounted for almost one-third of all vaccine misinformation found on social media in Brazil (Gilbert, 2019). The researchers emphasized that the posts were translated word for word into Portuguese, suggesting that this was a deliberate process rather than an automated one.

Anti-vaccination activists have gained a deep understanding of how to communicate effectively on social platforms and have developed techniques to take advantage of their unique characteristics, such as groups, ads, and trending topics. Along with aggressively promoting their own views, they also actively target and harass those who take opposing positions, effectively silencing many voices (Thielking, 2019; Wong, 2018).

In early 2020, a doctor who published a pro-vaccine video on TikTok was aggressively harassed online by an anti-vaccination swarm. Her colleagues created a 24/7 rotation of volunteers to block those who were harassing her and report them to the social platform. They created a "Block List" spreadsheet that they are now sharing with other doctors who are struggling with similar harassment campaigns so that they can preemptively ban the worst harassers from commenting on their pages (Glyn, 2020). Understanding the tactics of the anti-vaccination community is a critical first step when considering possible actions in these spaces.

Understanding the Increasingly Politicized Anti-Vaccine Movement

The disproportionate impact of the U.S. anti-vaccination movement on the rest of the world (BBC News, 2019b; Gilbert, 2019) makes it worthwhile to explore current trends in more detail. The U.S. anti-vaccine movement is very politically active in its pursuit of clearly defined policy goals, particularly related to childhood immunizations. This generally takes the form of opposing any strengthening of vaccination requirements or immunization-level transparency and sponsoring or supporting state legislation to create new types of exemptions to school-based immunization requirements.

In the United States, vaccine policy is set at the state level rather than the national level. As such, dozens of bills are introduced in state legislatures each year, including by anti-vaccine legislative advocacy groups. Grassroots activities in support of these bills appear to be coordinated by the National Vaccine Information Center, which runs a legislative advocacy portal and mailing lists, in addition to a regional or state sponsor. Some of the bills attempt to create personal belief exemptions—the right to opt-out based on philosophical objections—in states that do not currently offer them, or to require burdensome disclosure frameworks for physicians, such as mandates to discuss vaccine ingredients and manufacturing processes as part of the requirement to obtain informed consent. Some proposed legislation focuses on introducing or protecting "vaccine choice" for workers such as nurses in industries that mandate immunizations.

Besides sponsoring legislation themselves, anti-vaccine advocates mobilize their supporters to staunchly oppose laws that aim to close loopholes or improve immunization rates. Messaging around liberty, choice, and resisting government overreach has been the most successful narrative for galvanizing opposition, particularly among libertarian and Republican constituencies. In many states, public health bills often appear to be politicized along party lines. Most states now have at least one "health choice" group that takes a personal liberty angle to fundraise and activate local members to oppose school vaccination requirements. In California and elsewhere, these groups hire lobbyists to communicate with state legislators and oppose specific legislation. Fundraising appeals appear in anti-vaccine groups on social platforms (Call, 2019; Kirkner, 2019).

Dominant Anti-Vaccination Narratives and How They Work Online

Concerns about vaccinating began to emerge in the mid-1800s, with the introduction of the smallpox vaccination inspired by Edward Jenner's demonstration of the impact of this approach. The concerns "included sanitary, religious, scientific, and political objections" (College of Physicians of Philadelphia, 2020b). Religious leaders were troubled by the incorporation of material from cowpox because it introduced material from an animal into a human. Some distrusted medicine and Jenner's process, while others had alternative theories about how the disease spread. What's more, following an outbreak in which the government response was to make vaccination mandatory, political concerns emerged about individual liberty (Williamson, 1984).

Anti-vaccine sentiment has ebbed and flowed since then, but many of the movement's narratives have remained largely consistent (Smith, 2017):

- **Toxicity:** This narrative focuses on the claim that vaccines are unnatural or contain toxic ingredients and that homeopathy and healthy behaviors (such as eating organic foods and handwashing) are just as effective at preventing the spread of disease.
- **Religiosity:** This narrative often overlaps with concerns about what is "natural." It may include the idea that vaccines contain materials that are objectionable on religious grounds (such as cell culture systems originally obtained via abortion, or porcine ingredients) or that the human body is perfect as God made it, suggesting that vaccines are unnecessary or against God's law.

- **Liberty:** This narrative claims that individuals should enjoy unfettered "health freedom" and "medical choice" and that no government or employer should be able to tell people what to put in their bodies. The liberty argument is primarily related to political activism around immunization requirements for schools or professionals (e.g., flu shots for nurses).
- **Distrust of industry:** This narrative asserts that vaccines are produced by profit-motivated pharmaceutical companies, often leveraging anecdotes of past abuses by companies in which they ignored or concealed harm in pursuit of profit.
- **Safety:** This narrative claims that vaccines are unsafe (e.g., causing sudden infant death syndrome [SIDS], autism, or seizures); that they are under-tested or untested, particularly across the entirety of the childhood immunization schedule; and that the risks outweigh the benefits. The safety narrative occasionally overlaps with conspiratorial narratives in the form of claims that the CDC is concealing findings of harm.
- **Conspiracy:** Distrust of government and authority is heavy in anti-vaccine narratives and there are a myriad of conspiratorial claims: that the U.S. government has covered up information about vaccines and a link to autism; that George Soros and Bill Gates are part of a population control program; that those behind pro-vaccine activism online are paid shills; that doctors and politicians have been bought off by "big pharma"; that anti-vaccine doctors have been murdered for revealing the truth about vaccines; and that vaccines disproportionately cause autism in young black males.

As Amin et al. (2017) argue, it is necessary to understand how these moral values are associated with vaccine hesitancy. The researchers found that values associated with "purity" and "liberty" are correlated with vaccine hesitancy and therefore need to be woven more frequently into pro-vaccine messaging.

Since anti-vaccination narratives have been present since the 1800s, the question of what is new in the era of social networks must be addressed. First, the consolidation of extremely large, global audiences onto a handful of social platforms ensures that anyone with a message to spread can have significant reach. In contrast, when the audience ecosystem was more fragmented, activists had to work harder on multiple platforms or with multiple media entities to spread their message.

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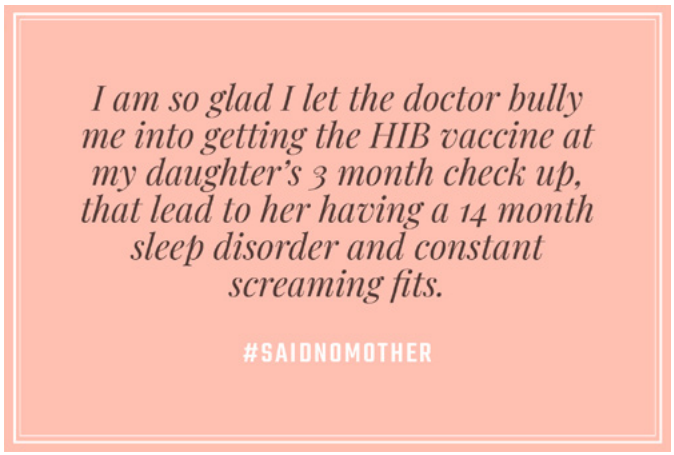
Second, it is easier than ever to target precisely the right message to the audience most likely to receive it. The ad-based business model of social platforms enables them to develop detailed profiles of individual users and to sell the means to target those users. As a result, anti-vaccine activists are able to grow their movement by targeting users based on the narrative most likely to resonate, leveraging paid ads and demographic or interest-based targeting tools. Ads also enable a specific user to be retargeted; if someone demonstrates interest by clicking through to an anti-vaccine site, the owner of the site can later retarget that individual with related content.

Reporting from *The Guardian* in February 2019 (Wong, 2019) and Buzzfeed in January 2020 (Haskins, 2020) demonstrates that the targeting of anti-vaccination advertising was and remains a problem on Facebook. Haskins's reporting showed that Facebook is hosting ads for an online pamphlet falsely claiming that the vaccine for whooping cough is unsafe. When asked for comment, Facebook clarified that it "does not have a policy that bans advertising on the basis that it expresses opposition to vaccines"; the policy only bans ads containing specifically false information (based on the findings of Facebook's third-party fact-checking partners) related to vaccines.

Additionally, in millions of online groups and message boards, users declare their affinity for certain topics simply by joining. Members of groups for new mothers, organic or vegan recipe groups, "crunchy" lifestyle boards, and even Twitter conversations involving community-preferred hashtags enable the anti-vaccine movement to spread its content much as a savvy marketer would. As political activity around vaccines has increased in response to recent outbreaks, the anti-vaccine movement has made it a priority to change the perception that it is a movement of the affluent, "hippie" left. The liberty-oriented "vaccine choice" argument has been targeted at libertarian and right-wing communities, where it often merges with the religious choice argument. Similarly, the black community has been targeted with the conspiracy theory that young black males are disproportionately vulnerable to autism if they receive the MMR vaccine (Lacapria, 2015; Schumaker, 2019).



Finally, social media platform algorithms play a role in spreading content across a broader network. These content curation and recommendation algorithms tend to amplify content that is emotionally resonant, while sharing features enable virality at high velocity. Several of the anti-vaccine communities on Facebook have tens of thousands of members or more; these individuals re-share content, serving as amplifiers to their broader networks. Furthermore, the first-person narratives and sometimes sensational conspiratorial claims of anti-vaccine content may generate significant user engagement, prompting the algorithm to identify the content as something worth pushing into the feeds of more users. As a December 2019 article by NBC News reported, "The most viral pieces of fake health news pushed far-reaching conspiracies between governments and medical communities and suggested ditching common medical treatment of life-threatening diseases for unproven cures. The top 50 articles garnered more than 12 million shares, comments and reactions this year, mostly on Facebook" (Zadrozny, 2019).

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We must also address the role of the mainstream media, particularly as professional content is often then shared on the social web. Narratives are delivered to the public via both online grassroots action and media coverage of prominent influencers. For example, Jenny McCarthy, a popular TV personality, was a primary disseminator of the safety narrative via her Green Our Vaccines events in which she repeatedly emphasized that she was not anti-vaccine, but rather pro-*safe*-vaccine (PBS FRONTLINE, 2015). This mantle has been taken up by Robert F. Kennedy Jr. and other prominent personalities such as Andrew Wakefield and Del Bigree, producers of the documentary *Vaxxed*. In Australia, Taylor Winterstein, the wife of a National Rugby League player, has created a following because of her position supporting "informed consent," "freedom of choice," and "vaccine injury awareness" (Scanlan, 2019).

The press coverage that these individuals generate allows them to spread a variety of narratives related to autism, conspiracies, toxicity, and religion, and then to declare that their primary motivation is simply to facilitate more safety studies. The strategy is to "move the goalposts," deeming that none of the peer-reviewed studies conducted over many years of research are sufficient.

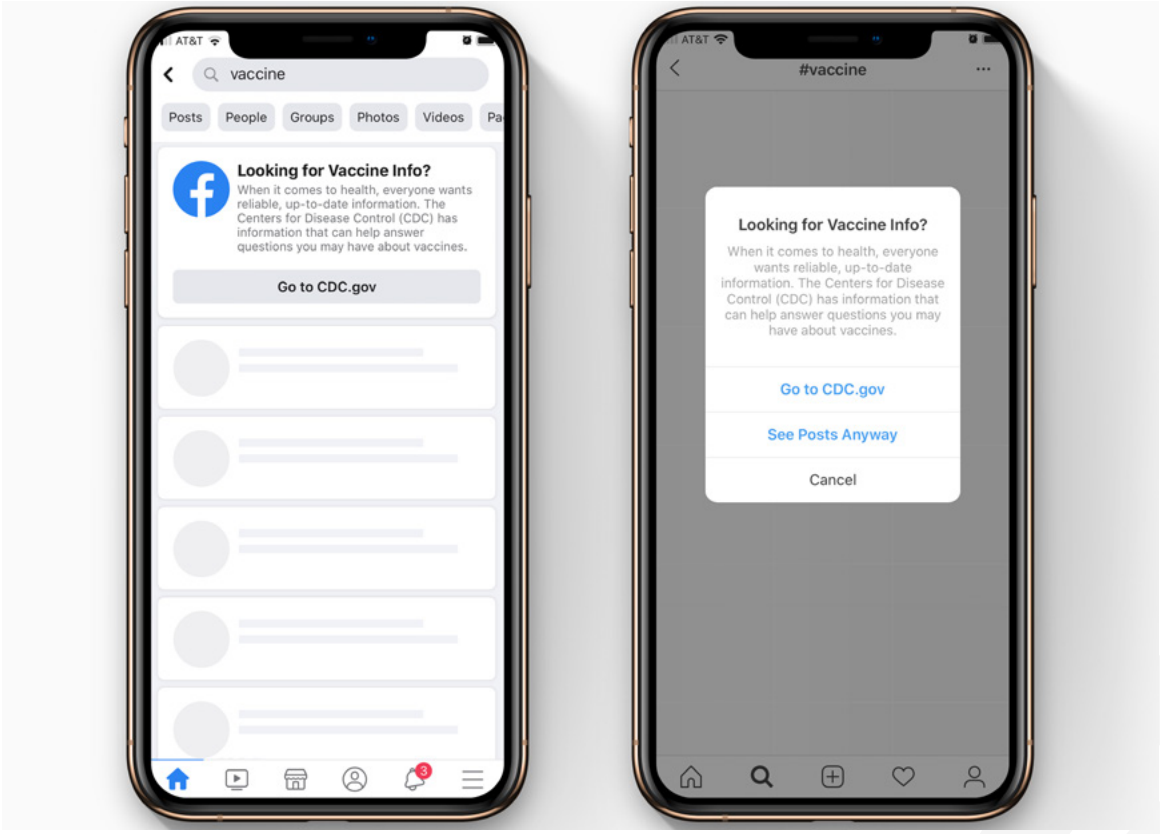
PLATFORMS: ANTI-VAX MESSAGES AND THE CORPORATE RESPONSE

Anti-vaccine activists have established a presence on all mainstream social platforms as well as on several emergent niche sites and apps and the platforms have responded with a range of policies. We expect the companies will continue to adjust these policies over time. As the firm response to COVID-19 has demonstrated, social media and search companies have become more willing to take stronger steps to ensure that users can easily access quality information and are less likely to encounter rumors and conspiracies. It will be interesting to see whether other health-related policies are strengthened as a result.

In this section, we outline how anti-vaccination content plays out on the different platforms and how policies compare for Facebook, Instagram, Google, YouTube, and Pinterest.

Facebook

Figure 5. Example of Facebook's pop-up box directing users to the WHO website for accurate health information



Update on September 4, 2019 at 8AM PT: *We are starting to roll out more ways to connect people with authoritative information about vaccines on Facebook and Instagram.*

The anti-vaccine movement is active across all of Facebook's primary features. There are Facebook pages created by organizers, influencers, and anti-vaccine media properties, and Facebook groups, some affiliated with pages and others organized by parents and grouped by region. Activists and media personalities also leverage Facebook Live for real-time communication with fellow activists. Until recently, some groups purchased ads to encourage users to join their communities or to send people to their websites or storefronts, but Facebook now prohibits ads that include false information about vaccinations.

On March 7, 2019, Facebook published a blog post titled "Combatting Vaccine Misinformation," detailing the company's initial response to curbing the spread of vaccine misinformation on the platform. In September 2019, Facebook made an addition to the existing policy and announced that educational pop-up windows would appear when a user searches for vaccine-related content or visits vaccine-related Facebook groups and pages. U.S.-based users would be connected via a pop-up window to the CDC to receive credible information on vaccines. If the user is outside the United States, Facebook would connect them to the WHO (see Figure 5; Bickert, 2019).

Instagram

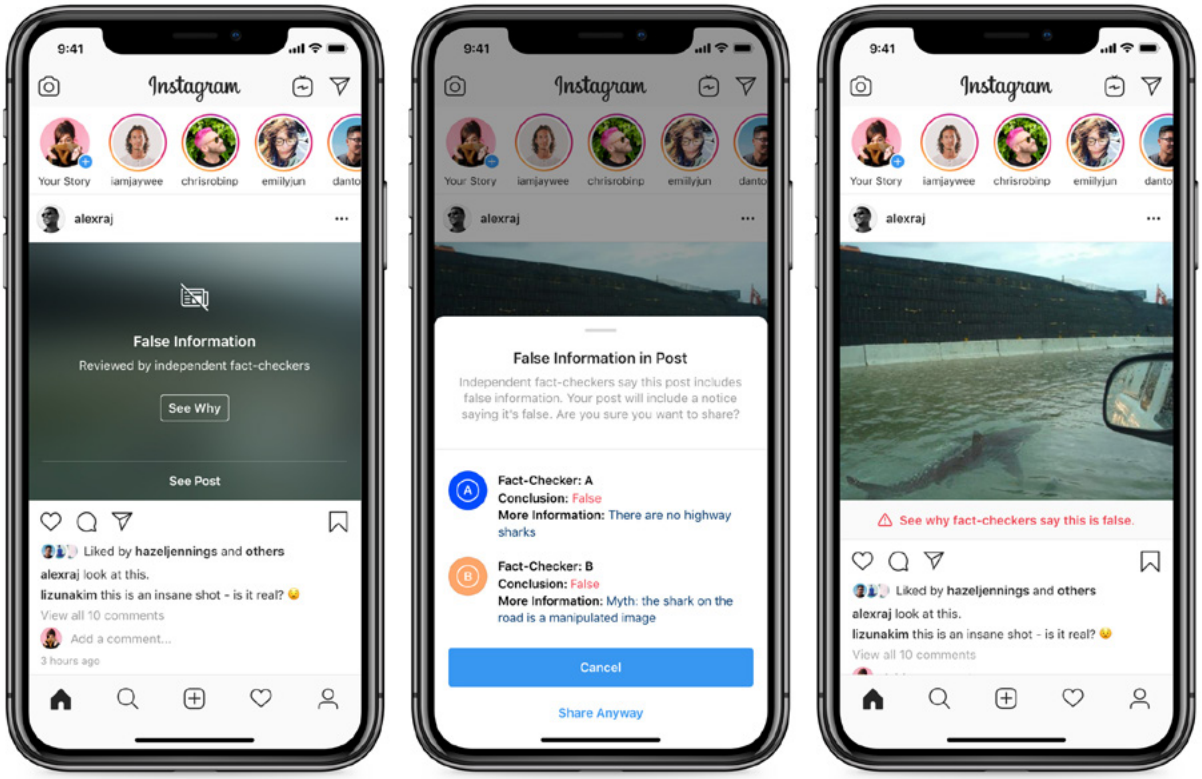
Instagram is leveraged primarily as a tool for sharing memes or short videos. Instagram content producers include high numbers of hashtags on their posts to improve discoverability and cross-promote content to potentially receptive audiences. Anti-vaccination content might include a hashtag like #vaxtruth or #vaccine, as well as some related to tangential topics with high ideological alignment, such as #NoGMO.

Despite the fact that Facebook owns Instagram, its policies sometimes differ slightly from those of its parent company. Shortly after the Facebook blog post about vaccine misinformation was published, Instagram announced its own policies, including the following:

- Instagram would begin hiding search results for hashtags that consistently return false information about vaccines.
- In May 2019, Instagram began working with third-party fact-checkers in the United States to help identify, review, and label false information (see Figure 6; Facebook, 2019). These partners independently assess false information to help the platform identify and reduce its distribution. When identified, the content also gets removed from the explore and hashtag pages.

- In August 2019, Instagram announced a new tool that allows users in the United States to flag content on the platform they believe to be false (Reuters, 2019). This mirrors a feature that already exists on Facebook.
- In December 2019, Instagram announced a global expansion of its fact-checking program (Facebook, 2019).

Figure 6. Example of Instagram's pop-up feature that appears when content has been fact-checked by Facebook's third-party partners

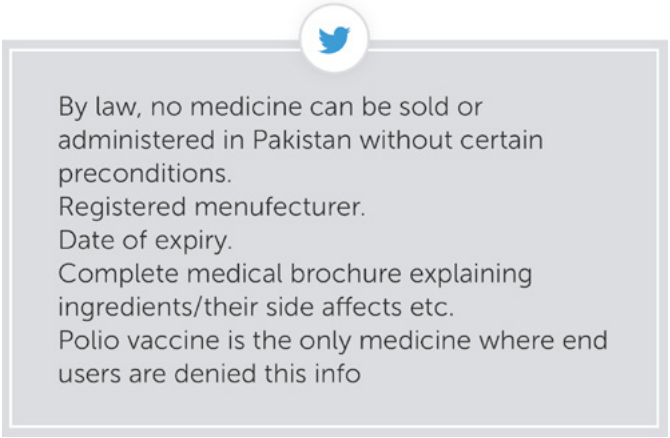


At a press conference in May 2019 when the U.S. rollout of the fact-checking partnership was announced, an Instagram spokesperson explained, "If the hashtag was #vaccines1234, if it contained a high proportion of known vaccine misinformation, we would block that hashtag entirely." "Known vaccine misinformation," the company explained, refers to claims that the WHO, the CDC, and similar organizations have verified as false. Instagram also clarified that other posts expressing anti-vaccine views but not confirmed as false can remain (Newton, 2019).

Twitter

Anti-vaccine activists are also prominent on Twitter. In addition to their own tweets, activists employ coordination to maximize message repetition and create the perception of a large movement and influencer outreach to maximize message amplification. Users network in groups to execute coordinated messaging strategies, targeting the same handles (press and legislators) at the same time or sharing identical memes in an attempt to achieve a dominant share of the voice within a hashtag and create a perception of broad support. Influencers with a large number of followers are leveraged in much the same way as a brand would employ them to market a product: sympathetic celebrities and media personalities re-share, repost, and otherwise amplify anti-vaccine memes, content, and political efforts (such as petitions). Anti-vaccine political activity on Twitter related to California Law SB-277, which was introduced to eliminate the personal-belief exemption to school vaccine requirements, is one example of how Twitter has been used to manipulate legislation (DiResta & Lotan, 2015).

Twitter is a vehicle for disinformation in many countries around the world. During the panic around the polio vaccine in Pakistan in 2019, tweets were a significant source of disinformation. A tweet posted by a prominent local influencer whose account has over 270,000 followers amplified rumors about children getting sick due to the polio vaccine. The tweet then received hundreds of retweets and likes.



Anti-vaccine activists similarly use social media marketing best practices to cross-promote hashtags, linking anti-vaccine hashtags to unrelated popular topics (e.g., posting vaccine conspiracies about black children using the popular hashtag #blacklivesmatter). They also attempt to co-opt "establishment" hashtags created by public health entities such as the CDC (#VaxWithMe, #Vaccines, or #VaccinesWork). Anti-vaccine activists have prioritized developing the groups and networks required to execute coordinated actions more effectively than pro-vaccine organizations, which means the former are often better positioned to create more activity in a targeted hashtag, even if it was originally created by the pro-vaccine community. As a result, positive vaccine messages are buried under a flood of opposing content. Harassment is also a common strategy on Twitter, with coordinated

groups of anti-vaccine activists attacking doctors, public health officials, organizations, and parents who have spoken out in favor of vaccines or shared a story in which they were personally impacted by vaccine-preventable disease.

Anti-vaccine activists also curate their own persistent hashtags:

- #CDCWhistleblower, a hashtag dedicated to the conspiracy theory that a CDC scientist attempted to expose a government cover-up related to MMR and autism in young black males but was silenced.
- #Vaxxed and #PrayBig, to share content related to the movie *Vaxxed*.
- #WeDid and #HearThisWell, a visual-meme-driven hashtag in which users share photos and videos of autistic children or SIDS cases. The text or audio contains a variant of the statement "#wedid vaccinate and look what happened."

Bots, or automated accounts, are also a known issue on Twitter, but their use by anti-vaccine activists represents a small fraction of overall activity. When automated tools are deployed, they are used primarily to push out a steady stream of content into hashtags deemed important.

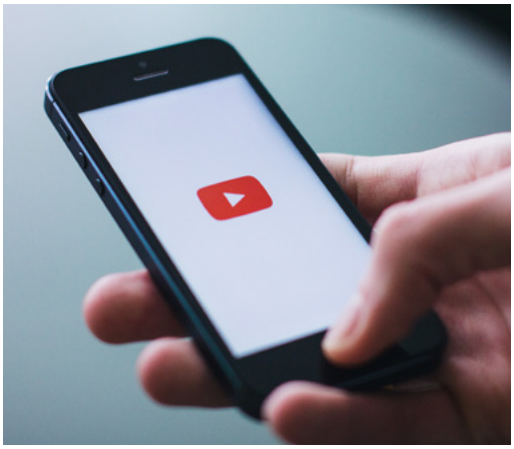
Figure 7. The pop-up advisory Twitter users see when they search for keywords associated with vaccines

On May 10, 2019, Twitter announced the launch of a new tool to tackle anti-vaccination content on the platform. When someone searches for certain keywords associated with vaccines, a prompt directs individuals to a credible public health resource (Harvey, 2019). The company partnered with the U.S. Department of Health & Human Services for #KnowTheFacts and an in-app message appears when users search for vaccine-related terms that points them to vaccines.gov for factual health information (Figure 7).

YouTube

A popular platform for hosting anti-vaccine videos, YouTube offers a distribution mechanism of its own via a recommendation engine that suggests new videos to users. Many anti-vaccine organizers and influencers maintain their own YouTube channels. Following the release of *Vaxxed*, the movie's production team traveled the country in a bus, recording "vaccine injury" anecdotes from parents. The videos, which were often live-streamed to other apps such as Periscope, were designed for maximum emotional resonance. Many include severely autistic, nonverbal children and feature a parent warning others not to make the same mistake they allegedly did.

Many other channels are conspiratorial in nature, purporting to expose the cover-up of a link between vaccines and autism. In one 2018 study, academics analyzed 560 YouTube videos "related to the link between vaccines and autism or other serious side effects on children" (Donzelli et al., 2018). They found that most of the anti-vaccine videos (392 of the 560) focused on supporting this misinformation and that the number of anti-vaccine videos posted to YouTube was increasing every year.



On January 25, 2019, YouTube announced that it would be redesigning its recommendation engine to prevent the platform from promoting conspiracies and false information to users. Vaccine-related content wasn't discussed explicitly as part of this announcement, but a month later, on February 22, 2019, YouTube announced that it would prevent channels that promote anti-vaccination content from running advertisements. In emails to journalists, the company stated, "We have strict policies that govern what videos we allow ads to appear on, and videos that promote anti-vaccination content are a violation of those policies. We enforce these policies vigorously, and if we find a video that violates them, we immediately take action and remove ads" (Shu, 2019).

On March 7, 2019, YouTube announced that it would be rolling out a feature that shows fact-checks when people search for sensitive topics. This feature is currently available to some users in India (Dixit, 2019). While particularly motivated by misinformation circulating during the most recent conflict between India and Pakistan, the fact-check pop-up will also apply to false health information.

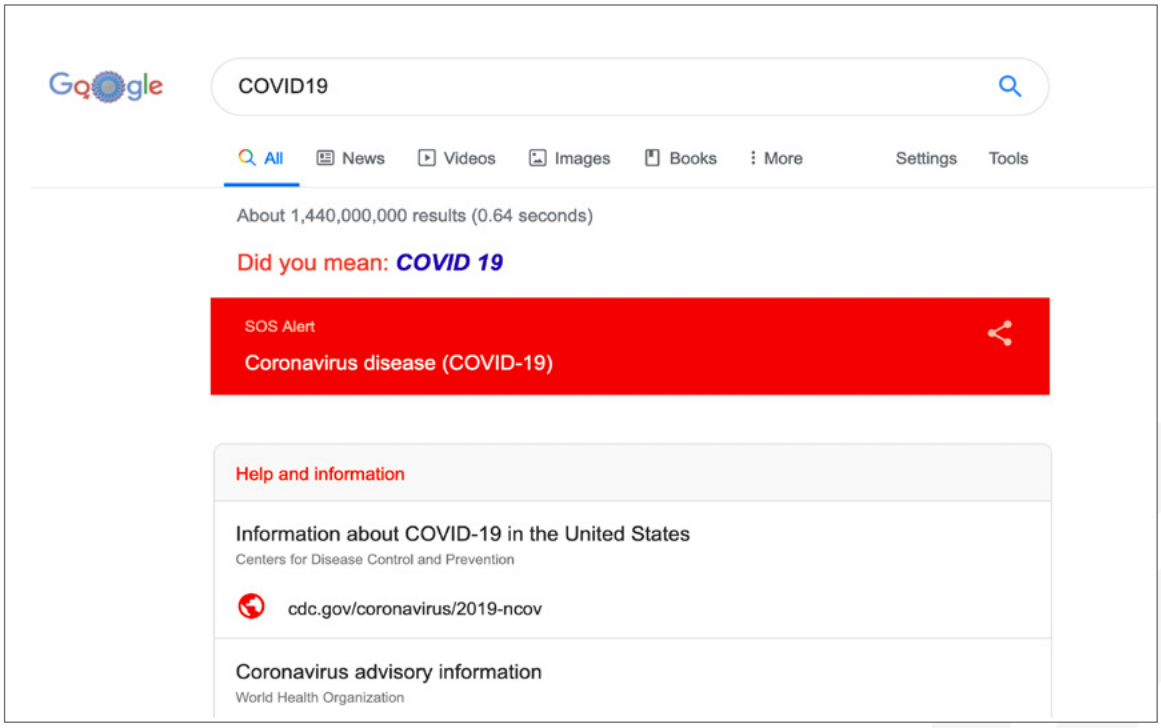
Google Search

While not a social network, Google Search is important as a central source of information for those seeking out vaccine narratives. Google does incorporate social signals into results but tries to ensure that it is returning high-quality information related to public health as part of a longstanding framework called "Your Money or Your Life" (McGee, 2013). The framework recognizes the unique role that Google Search plays as one of the first tools that people turn to as they look for health information and the responsibility the company bears for returning accurate information.

On March 20, 2018, Google announced a partnership with the National Academies of Sciences, Engineering, and Medicine to explore ways to mobilize expertise to counter misinformation on the web related to science, engineering, and health (McNutt, Mote, & Dzau, 2018). However, there has been little concrete discussion of how this partnership impacts search results.

The new "SOS" treatment from Google for COVID-19—which pops up as a highly visible red alert and accompanying knowledge panel populated with the latest overview, symptom, and treatment information from authoritative sources—suggests a model for linking clearly to the WHO, the CDC, and other authoritative sources related to vaccinations (Figure 8).

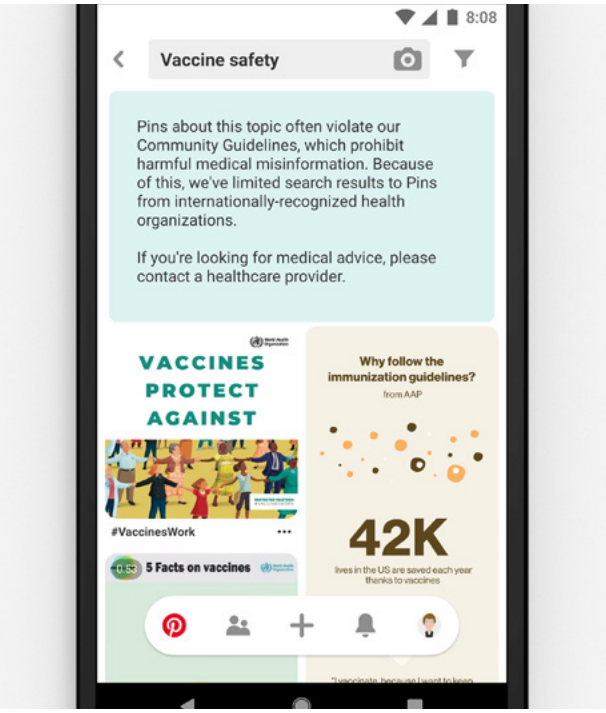
Figure 8. The new SOS search result that appears on Google when someone searches for information related to COVID-19



Pinterest

On August 29, 2019, Pinterest introduced a new experience for vaccine-related searches. Someone searching for "measles," "vaccine safety," and other related health terms can explore reliable results about immunizations from leading public health organizations, including the WHO, the CDC, the American Academy of Pediatrics (AAP), and the WHO-established Vaccine Safety Net, a global network of websites providing reliable vaccine safety information in various languages (see Figure 9; Ozoma, 2019).

Figure 9. Advisory on Pinterest when someone searches for vaccine-related content that links to a pin created with the AAP



A blog post announcing the changes explained, "This new search experience only shows content from leading public health institutions—you won't see any recommendations or comments on Pins in these results. We also won't show ads. We're taking this approach because we believe that showing vaccine misinformation alongside resources from public health experts isn't responsible.

"As we continue to tackle health misinformation, we remove it and the accounts that spread it from our service. But we also want to bring expert content onto Pinterest. We know we aren't medical experts, which is why we're working with professionals to inspire Pinners with reliable information about health" (Ozoma, 2019).

Closed Messaging Apps

Another major area of concern beyond social media and search companies are messaging apps such as WhatsApp. While WhatsApp has global dominance (1.5 billion users worldwide), other messaging apps are popular in certain countries, such as WeChat in China, LINE in Thailand, KakaoTalk in South Korea, Telegram in Iran, and Viber in Myanmar. These apps are either encrypted or their one-to-one nature makes it impossible to monitor what content is being shared.

CONCLUSION

It is important to understand that social media is fundamentally a peer-to-peer form of communication (Dubé et al., 2016). Online anti-vaccine communities share highly personal "lived experience" stories which may be far more persuasive than a top-down message from an authority figure (Brunson, 2013). User participation facilitates the development of personal connections and in many communities is considered a breach of social norms to challenge or attempt to contextualize a personal narrative, meaning that individual stories about vaccines supposedly leading to a child's autism largely go unchallenged. Furthermore, social media design choices have provided a dispersion mechanism for stories that eliminate traditional gatekeepers (such as fact-checkers and editors).

While online platforms have begun to take meaningful steps to combat vaccine misinformation, the anti-vaccine narrative endures. The ability of the pro-vaccine community to tell a more compelling story more persuasively and to spread its evidence-based message to broader audiences online is an imperative for public health.

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Renée DiResta is an expert on disinformation and media manipulation, with a particular focus on how social media platforms are used to distort public opinion. DiResta serves as the Technical Research Manager of the Stanford Internet Observatory, where she investigates the spread of malign narratives across social networks. She has advised Congress, the U.S. State Department, and senior executives on how best to understand and respond to the problem, and led a research team convened by the Senate Select Committee on Intelligence to investigate Russian interference in the 2016 presidential election. In 2017, DiResta was a scholar in the Presidential Leadership Scholars program.

Disclosure: Renée DiResta co-founded the parental advocacy organization Vaccinate California in 2015.

Claire Wardle, US Director of First Draft

Claire Wardle, Ph.D., is one of the world's experts on user-generated content, verification, and misinformation. Currently, she leads strategic direction and research for First Draft, a nonprofit that supports newsrooms focused on the challenges of reporting in an age of disinformation. In 2017, she authored the report *Information Disorder: An Interdisciplinary Framework for Research and Policy* for the Council of Europe. Wardle was previously a TED fellow working to improve the quality of the information ecosystem. She has also been a fellow at the Shorenstein Center for Media, Politics and Public Policy at Harvard's Kennedy School and held positions at the Columbia University Graduate School of Journalism and at the United Nations Refugee Agency. Wardle was a member of the World Economic Forum's Global Agenda Council on the Future of Information and Entertainment.

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