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Vaccine-Related Advertising in the Facebook Ad Archive

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Abstract

Background: In 2018, Facebook introduced Ad Archive as a platform to improve transparency in advertisements related to politics and "issues of national importance." Vaccine-related Facebook advertising is publicly available for the first time. After measles outbreaks in the US brought renewed attention to the possible role of Facebook advertising in the spread of vaccine-related misinformation, Facebook announced steps to limit vaccine-related misinformation. This study serves as a baseline of advertising before new policies went into effect.

Methods: Using the keyword 'vaccine', we searched Ad Archive on December 13, 2018 and again on February 22, 2019. We exported data for 505 advertisements. A team of annotators sorted advertisements by content: pro-vaccine, anti-vaccine, not relevant. We also conducted a thematic analysis of major advertising themes. We ran Mann-Whitney U tests to compare ad performance metrics.

Results: 309 advertisements were included in analysis with 163 (53%) pro-vaccine advertisements and 145 (47%) anti-vaccine advertisements. Despite a similar number of advertisements, the median number of ads per buyer was significantly higher for anti-vaccine ads. First time buyers are less likely to complete disclosure information and risk ad removal. Thematically, anti-vaccine advertising messages are relatively uniform and emphasize vaccine harms (55%). In contrast, pro-vaccine advertisements come from a diverse set of buyers (83 unique) with varied goals including promoting vaccination (49%), vaccine related philanthropy (15%), and vaccine related policy (14%).

Conclusions: A small set of anti-vaccine advertisement buyers have leveraged Facebook advertisements to reach targeted audiences. By deeming all vaccine-related content an issue of

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"national importance," Facebook has further the politicized vaccines. The implementation of a blanket disclosure policy also limits which ads can successfully run on Facebook. Under current policies, improving transparency and limiting misinformation are not separate goals. Public health communication efforts should consider the impact on Facebook users' vaccine attitudes and behaviors.

1. INTRODUCTION

Facebook has over two billion active users, making it one of the largest communities in the world.[1] In the United States, 68% percent of adults use the platform and more Americans get news from Facebook than any other website or single news outlet.[2,3] On Facebook, users engage with a personalized News Feed, where posts shared by friends appear alongside sponsored advertising content.[4] While public health researchers have frequently studied marketing strategies used to promote harmful products in print and broadcast media,[5,6] there is a critical lack of public health research on social media advertising.[7–9] Social media sites like Facebook offer advertisers an easy and inexpensive channel to reach narrowly-defined audiences in a relatively unregulated setting.[10] Each user sees advertisements tailored to their interests, habits, and online behaviors. This highly personalized tailoring makes Facebook advertising enormously successful, but also has limited opportunities for research.

We turned our attention to vaccine-related Facebook advertisements as the World Health Organization (WHO) listed vaccine hesitancy -- due, in part, to online misinformation -- among the top ten global health threats of 2019.[11] As parents delay or forgo recommended childhood vaccines, scholars have implicated the widespread circulation of misleading vaccine information online.[12–14] The Facebook platform, in particular, has been used to disseminate highly polarized user-generated content.[15–17] In early 2019, measles outbreaks across the U.S. drew media attention to the possible influence of vaccine-related Facebook advertising, but no academic studies have yet examined this issue.[18–20] These measles outbreaks only underscored the risk posed to global health by misleading health-related Facebook advertisements.[21] Whereas traditional advertising techniques might have failed to find a coherent audience of vaccine-hesitant individuals,[22] sophisticated algorithms can be used to micro-target individuals who are susceptible to vaccine opposition.

Our research was made possible through a new tool, Facebook Ad Archive (now called Ad Library).[23] In 2018, Facebook faced a string of high-profile scandals, including the misappropriation of personal data through Cambridge Analytica, and revelations that Russian operatives had weaponized Facebook advertisements, pages, and groups to illegally influence American elections.[24] The company faced calls for increased transparency from lawmakers and the public. In response, Facebook introduced Ad Archive, an effort to increase transparency and regain public confidence. Ad Archive provides users a searchable repository of advertisements related to politics and "issues of national importance".[23] Ad Archive made it possible to access the set of vaccine-related ads that were posted on Facebook and flagged as politically or nationally important. While Ad Archive does not include every Facebook ad, nor does it give many details about how users see and interact with an ad, it is the most extensive source of information that Facebook has provided about advertisements on its platform.

In the course of our research, rising controversy led Facebook to modify advertising policies related to vaccines.[25] Two of these proposed changes include removing advertisements that contain "misinformation" about vaccines (as defined by the Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO)), and also removing the ability of advertisers to selectively advertise using criteria like "interest in vaccine controversies".[25] The changes were announced in March of 2019, and while some appear to have gone into effect, the full impact of these policies remains to be seen. This analysis documents the advertising landscape prior to the implementation of new policies.

We present the first analysis of public health related Facebook advertising using the Ad Archive. We have three aims: 1) document the types of vaccine-related advertisements appearing on Ad Archive; 2) compare the subset of advertisements containing pro-vaccine content to those with anti-vaccine content; and 3) identify the strategies employed by the two largest anti-vaccine ad buyers. Our analysis demonstrates the value of the Facebook Ad Archive in understanding advertising campaigns related to vaccines, but also highlights some critical limitations of the platform.

2. Methods

2.1 Data Source

Facebook's primary revenue comes from selling advertising to show to users of their platform. The main attraction of Facebook as an advertiser is that they collect information on individual users' interests, demographic traits, social networks, and online behavior; information that, in turn, can be utilized to develop precise profiles for micro-targeting of advertisements.[26] For every available advertising slot, ad placement is determined through a continuous digital auction process. After algorithmically weighing factors including desired audience characteristics and budget, the single ad with the greatest "total value" is placed into that spot.[27] Facebook (and its subsidiary, Instagram) generated an estimated $55 billion in ad revenue in 2018.[28] The company works with advertisers to ensure successful ads, but they closely guard information related to proprietary advertising selection algorithms. As a result, many of the factors that determine advertising placement, and more specifically how they are combined, are not publicly known.[26] There are also fewer barriers to entry than in traditional advertising, as any user with a Facebook account and a credit card can launch an advertising campaign on Facebook in a matter of minutes.[29]

Unlike mass media, where anyone can watch, listen, or observe ads, or even Google, where anyone can issue queries to see what ads are served, since Facebook ads are microtargeted to specific users, it is impossible to know what ads are running on their platform at any given time. Ad Archive was introduced to create greater transparency into the Facebook advertising marketplace. To be included in Ad Archive, advertisements must be flagged as "relevant" – meaning related to politics or issues of "national importance". Facebook describes how each advertisement is screened through a combination of Artificial Intelligence (AI) and human review, typically within 24 hours of submission.[30] Advertisements about "Social Issues, Elections or Politics" are considered a special subset of advertisements, subject to additional disclaimer policies.[30] In the United States, twenty topics are listed as social issues, including "health".[31] Ad Archive is an important first step

in increasing transparency but provides only limited access to a narrowly defined subset of advertisements within a much larger advertising network. Nevertheless, it is the most information Facebook has provided on specific ads to date.

2.2   Data Collection

We searched the Ad Archive for "*vaccine*" to identify relevant advertisements in the U.S. We compiled results on multiple dates. Initial data collection was conducted December 13, 2018 and then updated on February 22, 2019. Since impression data is time sensitive, all advertisements that were still "active" and open to viewers during the earlier data collection points were updated at later dates. Search results vary each time a search is run, so the final dataset includes advertisements present at one or more data collection points. As will be discussed later, attempting to verify data points again in August 2019, we found the same search parameters produced different results. The Institutional Review Board at the University of Maryland reviewed protocols and ruled the dataset as exempt (#1363471–1).

2.2.   Study Sample

All advertisements from search results were included in the analysis. Two researchers (AJ & DK) manually exported data from Ad Archive into a spreadsheet. These data included whether an advertisement was active (on display to viewers); dates of activity; the advertisement title; and who paid for it (now labelled as a disclaimer). In many, but not all, instances, the advertisement title and the organization that paid for it were the same. In instances where a buyer was not explicitly identified, the advertisement title was used to identify a likely buyer (Figure 1). Relevant advertising images and videos were summarized in text.

A central piece of Ad Archive's push for transparency is the inclusion of "disclaimers" indicating who paid for each advertisement. While compiling information, researchers also indicated whether an advertisement had run without a disclaimer or had been removed for violating Facebook advertising policies. We identified two scenarios where removal occurs. Advertisements that appeared without a "paid for by" label are flagged with text that reads; *"This ad ran without a disclaimer. After the ad started running, we determined that the ad was about social issues, elections or politics and required the label. The ad was taken down."* However, the time frame for removal is not clear. Some advertisements were taken down immediately, while others may have run for weeks before being taken down. Additionally, some advertisements appear with a yellow alert icon to indicate that content violates advertising policies more broadly, along with a link to an overview of Facebook's policies (but no indication of the specific violation) (Figure 2). To complicate matters, policies surrounding removal are opaque, continually evolving, and may be applied retroactively. Most ads that ran without a disclaimer were not flagged with the icon, and some with the icon had complete disclaimers. For our purposes, any advertisements that were either explicitly removed and/or those that were flagged as "ran without a paid for by label" were both considered removed.

A critical measure of an ad's influence and success is the number of *impressions*: how often an advertisement was on screen in front of a member of the target audience.[32] When creating

a Facebook advertising campaign, buyers specify objectives that can be operationalized as exposure (measured in impressions), engagement (measured in clicks), or action (measured in conversions, e.g. signing a petition, joining a mailing list). Advertisement pricing corresponds to the level of engagement. As described earlier, pricing also reflects the level of competition for a given audience as determined in an Ad Auction process.[27] Ad Archive provides summaries of "Ad Performance" based on snapshots of impression data (Figure 3). Given the complexity of an advertisement's placement, impression data alone are not enough to understand the scope of the buyer's intended campaign, though they can suggest advertiser's suggestions.

Ad Archive performance data include categorical estimates for impressions (ranging from <1K to >1M) and price (ranging from <$100 to $10,000–$50,000). Demographic information is presented in advertisement performance snapshots using bar graphs. We translated data from these graphs into our own categorical measures. We assigned gender distribution as majority male or female. Our assignments for age distribution included: very young (including teens), young adult (majority aged 25–44), middle-aged adults (distribution includes adults both under and over age 44), and older adults (majority aged >44). However, not all age distributions demonstrated a clear pattern. Geographic distribution included international, national, and state-specific. Again, impression data reflects the characteristics of the audience that viewed the advertisement but may not necessarily indicate that advertisers used these same demographic criteria to tailor their advertisements.

2.3 Analysis

Two independent annotators (AJ & DK) assigned advertising content into three categories: pro-vaccine, anti-vaccine, and not relevant. We agreed upon this three-category coding scheme after experimenting with several other multi-category coding schemes. Each annotator assigned a code while manually importing advertising data. Discrepancies were discursively addressed, with a final category assigned by AJ. Relevant advertisements were unambiguously pro-vaccine or anti-vaccine; discrepancies often indication ambiguity and most of these advertisements were ultimately labelled "not relevant" (further described below). A calculation of inter-annotator reliability based on our initial coding of 38 ads (using a five-category coding scheme) was high, with an unweighted Fleiss' Kappa of 0.71 (CI: 0.55 −0.89).

The same annotators also conducted a thematic analysis of content to identify major themes within relevant advertising categories. After agreeing upon several categories, each annotator assigned one or more categories to each advertisement with final themes assigned by AJ. In this instance, discrepancies often meant both categories were applicable.

We ran descriptive statistics for relevant advertisements including Mann-Whitney U tests to compare the medians of the variables identified above between categories (significance level <0.05).

3. RESULTS

3.1 Characterizing the total dataset

Our first search in December 2018 resulted in 374 advertisements, and a second search in February 2019 produced 131 new advertisements, for a total of 505 advertisements. Advertisements ran from May 31, 2017 through February 22, 2019. Twenty-one advertisements were currently active; all others were inactive. After annotation, 197 advertisements were labelled "not relevant" and excluded from further analysis. This included advertisements recruiting for drug trials, promoting livestock and/or pet immunization, or advertisements using the word "vaccine" in a different context (e.g. as a metaphor). Advertisements were considered pro-vaccine if content encouraged vaccination or described the benefits of vaccination (or were directly challenging anti-vaccine arguments). Advertisements were considered anti-vaccine if they questioned vaccine safety or promoted vaccine choice. Of the 309 relevant advertisements, binomial tests show no significant difference between the frequencies of pro-vaccine advertisements (n=163, 53%) and anti-vaccine advertisements (n=145, 47%), *p=0.28*.

3.2 Comparing Pro and Anti Vaccine Advertising Content

There were significant differences in advertising characteristics (Table 1). The most immediate difference is reflected in the number of advertising buyers: despite similar numbers of advertisements, a Mann-Whitney U test indicates that the median number of ads per buyer was significantly higher for anti-vaccine ads, *U=1574, p=0.006*. There were only 27 unique buyers of anti-vaccine advertisements, compared to 83 unique buyers of pro-vaccine advertisements. Anti-vaccine ads were accordingly more concentrated: the top 5 anti-vaccine buyers accounted for 75% of anti-vaccine ads, while the top 5 pro-vaccine buyers accounted for only 35% of pro-vaccine ads (Figure 4).

This appears to have had consequences for how the advertisements were processed by Facebook. Pro-vaccine ads were more likely to violate Facebook's Terms of Service (TOS) by not having identified their funding source. In general, first time ad-buyers were more likely to violate the TOS in this way, $\chi^2(1)=15.84$, *p<0.001*. Although pro-vaccine and anti-vaccine first time buyers did not significantly differ in their violation rates, $\chi^2(1)=3.44$, *p=0.06*, 74% of these buyers were pro-vaccine. In contrast, we did not detect a difference in the rates with which ads were taken down for unspecified violations (see Table 1).

Thematically, pro-vaccine advertisements fell into five categories: vaccine promotion (n=72, 49.3%), vaccine-related philanthropic work (n=25, 15.3%), promoting vaccination policy (n=23, 14.1%), news (n=20, 13.7%), and opposing anti-vaccine views (n = 24, 14.7%) (Table 1). Most pro-vaccine advertisements (81%) focused on a specific vaccine, with influenza vaccine the most common. Promotional advertisements were typically vaccine specific (95.8% name a single vaccine), geographically tailored (77.8% ran in a single state), and paid for by a local health organization (for instance, The Minnesota Department of Health or Blue Cross Blue Shield of Kansas City). Philanthropic advertisements promoted vaccines indirectly, often by highlighting international vaccine campaigns. For instance, the Bill & Melinda Gates Foundation accounted for 47% of the philanthropic advertisements

with 18 ads about ongoing global campaigns to end polio. Policy-focused advertisements frequently included local activist groups or political candidates sharing petitions, links to meetings, or outlines of policy goals. News advertisements typically presented stories of scientific breakthroughs or news of active outbreaks. A heterogenous subset of advertisements could be described as opposing anti-vaccine views including dispelling vaccine myths (n=7), campaign advertisements against vaccine choice candidates (n=8), even selling tee-shirts with a *"Got Polio? Me neither. Thanks, Science"* message (n=2).

Anti-vaccine advertisements were thematically more unified (Table 1), with substantial overlap between the related categories including describing perceived harms of vaccination (n=80, 55.2%), promoting vaccine choice (n=47, 32.4%), and revealing purported institutional fraud (n=29, 18%). The majority of anti-vaccine ad content (n= 119, 82.1%) opposed vaccination in general (without identifying specific vaccines). In these ads, the most common approach was to describe the risks of vaccination. Two common tactics include presenting parental accounts of injured children (e.g. *"Our family was full of life and love, but then the DTaP Vaccine stole that away…"*; and presenting research on alleged vaccine harms or flaws in medical research (e.g. *"Flu Shot Bombshell. Vaccine Safety Testing Never Done…"*). Closely related were advertisements alleging medical, governmental, and pharmaceutical corruption related to vaccines. These advertisements describe medical malfeasance, coverups, and corruption, often linked to purported evidence of vaccine harms. A subset of advertisements focused on parental rights and vaccine choice movements. While these advertisements may not directly challenge vaccination safety, they opposed mandatory vaccination, informed parents about vaccine exemptions, and/or extolled the benefits of "natural" immunity. Many came from activist groups at the state level, particularly Michigan, Ohio, Colorado, Mississippi, and Texas. Anti-vaccine advertisements of all types commonly include links to further resources, events to attend, seminars to screen, and products to buy.

Advertisement performance varied (Table 2). Most advertisements are inexpensive: 93% of all advertisements cost less than $500. Pro-vaccine advertising budgets were significantly lower (77% of advertisements <$100) compared to anti-vaccine advertisements (55% of advertisements <$100), *Mann Whitney U=9732.5, p=0.008*. Impression counts for pro-vaccine advertisements were also significantly lower (40% of ads <1K views) compared to anti-vaccine advertisements (14% of ads <1K views), *U=8516, p<0.001*. With slightly higher budgets ($100–$499), advertisements routinely reached audiences between 5,000 and 50,000. This category included 41% of anti-vaccine advertisements but only 12% of pro-vaccine advertisements. At the upper end, the three most costly advertisements ($5,000–$50,000) were pro-vaccine. Interestingly, all three were removed for running without a disclaimer, but not before reaching hundreds of thousands of impressions. Without a disclaimer, buyers cannot be confirmed, but based on content appear to have been (1) Trumenba, the pharmaceutical manufacturer of a meningitis B vaccine, and (2) the Centers for Disease Control and Prevention with two "*HPV Vaccine is Cancer Prevention*" ads.

75% of advertisements target a majority (or entirely) female audience (Table 2). However, compared to pro-vaccine advertisements, anti-vaccine advertisements targeted more female audiences, *U=10192, p=0.04*. There was no significant difference between the median

audience ages for pro- and anti-vaccine advertisements, *U=9335, p=0.56;* however, Table 2 shows that anti-vaccine advertisements were more concentrated, targeting young adults most likely to have small children, whereas pro-vaccine advertisements reach audiences more evenly distributed between age categories. In general, pro-vaccine advertisements were more likely to focus on smaller geographical areas than anti-vaccine advertisements, *U=8805, p<0.001.* Within ads targeting specific states, pro-vaccine and anti-vaccine ads focused on different regions of the country, $\chi^2(32) = 11.88, p < 0.001$, with pro-vaccine ads focused on several different states, especially Texas. In contrast, anti-vaccine ads focused on a small number of states, especially Michigan, Ohio, and, in 2019, Washington – the site of an ongoing measles outbreak (Figure 5).

3.3   Specific Anti-Vaccine Advertising Strategies

One of the ways Ad Archive aims to increase transparency is by identifying and labeling advertisement buyers. Among anti-vaccine advertising buyers, two were responsible for a majority (54%) of content: World Mercury Project (*n*=47) and an individual buying for the group Stop Mandatory Vaccination (*n*=36).

World Mercury Project (WMP) and the closely aligned Children's Health Defense (CHD) are part of an advocacy group chaired by a political celebrity spokesperson, largely centered on the belief that vaccines are harmful and are contributing to an "epidemic of childhood chronic illness".[33] While Ad Archive lists WMP/CHD with 90 ads, only 47 appeared in our dataset, suggesting that not all advertisements were vaccine-related, or could be identified with our search parameters. Content was consistent under both WMP and CHD labels and included a mixture of newsletters, video advertisements, and endorsements for books, products, and seminars. Most advertisements (85.1%) linked back to the group's webpages. Two ads linked directly to Indiegogo.com, a fundraising platform, with an appeal to support the group and related legal fees.

The group, Stop Mandatory Vaccination (SMV), is run by a California-based activist, who utilizes crowdfunding to post these advertisements and pay for personal expenses.[34] Ad Archive lists 52 ads for SMV; our search parameters produced 36 (72%) of these. Many advertisements featured stories of infants allegedly harmed by vaccines, using taglines like, "*Healthy 14 week old infant gets 8 vaccines and dies within 24 hours.*" Other advertisements shared videos of parents describing their vaccine-injured children and/or how to live a life without vaccines. One advertisement promoted a candidate running on a vaccine choice platform in California. Several others included links to products and events.

4.   Discussion

This is the first academic inquiry to use Ad Archive data to study Facebook advertising focused on a public health issue, like vaccination. While this work describes how vaccine-related advertisements operate on Facebook, it introduces broader questions of Facebook advertising regulations and transparency. This research not only captures the advertising landscape in the lead-up and early days of the 2019 measles outbreak in the U.S., it also can serve as a baseline to assess the impact of Facebook's new proposed measures to regulate vaccine-related misinformation in advertising.

It is noteworthy that Ad Archive includes vaccine-related content. Public discourse on vaccination is increasingly politicized in the U.S., even as most individuals report support for vaccination.[35,36] The choice to broadly categorize all vaccine-related advertising content as political and/or of national importance plays into this politicization, indirectly reinforcing the notion that vaccines are controversial and legitimizing the idea of vaccine "debate". The current disclosure policy suggests that sharing any vaccine-related information constitutes a political act. Facebook is not alone in taking this sweeping approach; Pinterest recently limited users ability to search for any vaccine related content, from any source.[37] Recognizing the need to monitor and limit *some* vaccine-related content does not necessarily mean that *all* vaccine-related content must be treated the same. We've demonstrated that pro-vaccine advertisements are significantly different than anti-vaccine advertisements, in their reach, audience, and intended goals. However, until better tools are developed, or procedures implemented, Facebook's current advertising screening practices have limited the ability of health organizations to engage in vaccine promotion, while other savvier groups can spread misleading vaccine information with relatively few obstacles.

Ad Archive provides users with a sense that Facebook advertisements are being screened and regulated based on content, when, in fact, they do not seem to be. We are not the first to criticize Facebook's limited attempts to increase transparency,[29] but our findings suggest that Facebook's focus on transparency was primarily related to strict enforcement of disclosure practices for advertising buyers but did not (prior to the implementation of new policies) consider the reliability or accuracy of advertising content. Additionally, of the subset of ads removed for non-disclosure related issues, Facebook does not provide enough information to make it clear what rules had been violated or why ads with similar content were not removed.

In practice, disclosure of the advertising buyer alone may not be enough to make an informed decision whether to trust its content. For instance, the National Vaccine Information Center (NVIC) sponsored several vaccine choice advertisements, and based strictly on the name, a viewer may surmise that this group is affiliated with federal public health programs, when in actuality, it is a non-profit advocacy group opposed to vaccination with a long history of controversial lobbying.[38] Again, by focusing on buyers and not content, problems stemming from the unchecked spread of vaccine-related misinformation remain unaddressed.

Weeks after this analysis was completed, Facebook announced new policies to "reject" advertisements promoting vaccine misinformation.[25] Under this criteria, outright falsehoods may be removed, but alternative frames (like the language of "vaccine freedom" or "choice") will likely remain. In this dataset, roughly a third of anti-vaccine advertisements used a choice-based argument. Given the ambiguity of new policies and the fact that many anti-vaccine advertisements link back to websites full of unverified information, we expect that advertisers will adapt to the new regulations with more subtle ads, but that the misleading content will still be widely available. The ability of Facebook to carry out this policy and the consequent efficacy of these changes remains to be seen. Facebook currently treats improving transparency and limiting misinformation as two separate goals, but this dataset demonstrates that these issues are related.

The role of these advertisements in the larger online economy should be considered. At the time of analysis, Ad Archive currently contained more than 2 million advertisements worth an estimated $495 million dollars. While vaccine-related advertising reflected only a fraction of that total, the advertisements we studied reflect the growing industry that profits directly off of vaccine controversy.[39] While Ad Archive includes groups that have traditionally benefited financially from vaccination (e.g. pharmaceutical companies), it highlights the growing presence of advertising buyers that profit directly from the controversy. This industry relies on anxious parents, typically using advertisements that highlight the harms of vaccination and then soliciting donations to fund their advocacy work (as seen by the two largest anti-vaccine buyers, WMP/CHD and SMV).[34,40] A handful of pro-vaccine advertisers may also profit from outrage directed at anti-vaccine groups.[19] Since advertising drives the online economy, Facebook's own financial stake should be taken into account as a possible conflict of interest -- Facebook faces mixed incentives when enforcing strict scrutiny of advertising buyers.[10]

The real-world impact of Facebook advertising is difficult to calculate. Experts are still debating the net impact of a few thousand illegal Facebook advertisements on the outcome of the 2016 presidential election.[41] Our sample is much smaller, but when discussing infectious disease outbreaks and vaccine behaviors, even slight declines in immunization rates can have serious consequences. Particularly troubling, at tail-end of our collection of our dataset, we observed that as a measles outbreak was announced in Washington State[42], a major anti-vaccine advertiser launched multiple advertisements describing the risks of vaccination that appeared to target women of child-bearing age in Washington State. Seven of these ads were in our dataset and all but one received thousands of impressions. We cannot definitively connect a Facebook advertisement to specific measles cases, but the indirect impact of these ads on the media environment and subsequent vaccination rates should not be discounted.

4.1   Limitations

This analysis would not be possible without access to advertisements through Ad Archive; however, there are some inherent challenges to using this dataset that have limited our analysis. In late 2018, we requested access to a Facebook API to work directly with Ad Archive Data but did not receive a timely response. Instead, we manually compiled our dataset. The irregular presentation of data on Ad Archive, the variability of search results over time, and the evolving practices regarding political/nationally important advertisements makes it very challenging to maintain a complete database. Other researchers have gone so far as to describe the platform as "broken".[38] Nevertheless, as the only repository of anti-vaccine related advertisements available for research, we believe the value of this dataset outweighs these limitations.

Another major limitation of this tool relates to the impossibility of discerning a buyer's campaign objectives or intended audience with impression data alone. For instance, our dataset reveals that most vaccine-related advertisements reach majority female audience, but except in cases with a 100% female audience, we cannot assume the buyer explicitly filtered by gender. Similarly, by omitting raw data and using broad categories, the true price per

impression cannot be calculated. With the information provided, it appears anti-vaccine advertising buyers prioritize simple impressions (which may be cheaper) than high engagement strategies, thus giving the appearance of reaching larger audiences with lower budgets.

5. Conclusions

Facebook Ad Archive is a new tool that continues to evolve. For researchers, the current limitations of Ad Archive may hinder some types of analysis, but the data are novel and offer the possibility of identifying major advertising trends for some topics. For vaccine-related advertising, it appears that anti-vaccine advertisers seem better able to navigate Facebook's ad requirements and to leverage low cost advertisements into user impressions. The extent to which Facebook's advertisements, coupled with other social media channels, undermine public trust in vaccinations, and more broadly, the government agencies charged with protecting the public's health, is beyond simply worrisome. Public health communication efforts need to consider what exposure to this content may have on Facebook users' vaccine attitudes and behaviors, and determine feasible means to counter such misinformation. This is particularly important as Facebook's internal mechanisms for flagging and removing advertisements have significant limitations. Future work will need to assess whether current advertising regulations can accomplish the intended goal of reducing vaccine misinformation.

References

1. Facebook Newsroom. https://newsroom.fb.com/company-info/. Published 2019 Accessed May 16, 2019.

2. Matsa KE, Shearer E. News Use Across Social Media Platforms 2018 Pew Research Center; 2018 https://www.journalism.org/2018/09/10/news-use-across-social-media-platforms-2018/. Accessed March 14, 2019.

3. Shearer E Social Media Outpaces Print Newspapers in the U.S. as a news Source. Pew Research Center https://www.pewresearch.org/fact-tank/2018/12/10/social-media-outpaces-print-newspapers-in-the-u-s-as-a-news-source/. Published 12 10, 2018 Accessed May 16, 2019.

4. Metz C How Facebook's Ad System Works. New York Times. 10 12, 2017:3.

5. Warner KE. Tobacco industry response to public health concern: a content analysis of cigarette ads. Health Educ Q. 1985;12(1):115–127. [PubMed: 3997535]

6. Grier SA, Kumanyika S. Targeted marketing and public health. Annu Rev Public Health. 2010;31:349–369. [PubMed: 20070196]

7. Richardson A, Ganz O, Vallone D. Tobacco on the web: surveillance and characterisation of online tobacco and e-cigarette advertising. Tob Control. 2015;24(4):341–347. [PubMed: 24532710]

8. Chu K-H, Sidhu AK, Valente TW. Electronic cigarette marketing online: a multi-site, multi-product comparison. JMIR Public Health Surveill. 2015;1(2).

9. Barry AE, Johnson E, Rabre A, Darville G, Donovan KM, Efunbumi O. Underage access to online alcohol marketing content: a YouTube case study. Alcohol Alcohol. 2014;50(1):89–94. [PubMed: 25411395]

10. Speicher T, Ali M, Venkatadri G, et al. Potential for Discrimination in Online Targeted Advertising In: HAL. Vol 81 New York, NY; 2018:1–15. https://hal.archives-ouvertes.fr/hal-01955343/file/Speicher-etal_PotentialAdDiscrimination_FAT2018.pdf. Accessed March 11, 2019.

11. World Health Organization. Ten Threats to Global Health in 2019. https://www.who.int/emergencies/ten-threats-to-global-health-in-2019. Published 2019.

12. Jolley D, Douglas KM. The effects of anti-vaccine conspiracy theories on vaccination intentions. PloS One. 2014;9(2):e89177. [PubMed: 24586574]

13. Kata A A postmodern Pandora's box: anti-vaccination misinformation on the Internet. Vaccine. 2010;28(7):1709–1716. [PubMed: 20045099]

14. Dredze M, Broniatowski DA, Hilyard KM. Zika vaccine misconceptions: A social media analysis. Vaccine. 2016;34(30):3441. [PubMed: 27216759]

15. Schmidt AL, Zollo F, Scala A, Betsch C, Quattrociocchi W. Polarization of the vaccination debate on facebook. Vaccine. 2018;36(25):3606–3612. [PubMed: 29773322]

16. Vanderslott S Exploring the meaning of pro-vaccine activism across two countries. Soc Sci Med. 2019;222:59–66. [PubMed: 30605800]

17. Hoffman BL, Felter EM, Chu K-H, et al. It's not all about autism: The emerging landscape of anti-vaccination sentiment on Facebook. Vaccine. 2019.

18. Pilkington E, Glenza J. Facebook under pressure to halt the rise of anti-vaccine groups. The Guardian. https://www.theguardian.com/technology/2019/feb/12/facebook-anti-vaxxer-vaccination-groups-pressure-misinformation. Published 2 12, 2019.

19. Madrigal AC. The Small, Small World of Facebook's Anti-vaxxers. The Atlantic. 2 2019 https://www.theatlantic.com/health/archive/2019/02/anti-vaxx-facebook-social-media/583681/. Accessed March 1, 2019.

20. Telford T. Facebook will consider removing or demoting anti-vaccination recommendatiosn amid backlash. The Washington Post. https://www.washingtonpost.com/business/2019/02/15/facebook-will-consider-removing-or-demoting-anti-vaccination-recommendations-amid-backlash/?utm_term=.84e6ecaff59c. Published 2 15, 2019.

21. Dredze M, Broniatowski DA, Smith MC, Hilyard KM. Understanding vaccine refusal: why we need social media now. Am J Prev Med. 2016;50(4):550–552. [PubMed: 26655067]

22. Kahan DM, Braman D, Cohen GL, Gastil J, Slovic P. Who fears the HPV vaccine, who doesn't, and why? An experimental study of the mechanisms of cultural cognition. Law Hum Behav. 2010;34(6):501–516. [PubMed: 20076997]

23. Ads Related to Politics or Issues of National Importance: About the Ad Archive. 2019 https://www.facebook.com/business/help/2405092116183307. Accessed January 4, 2019.

24. Lapowsky J. The 21 (And Counting) Biggest Facebook Scandals of 2018. Wired. 1 2018 https://www.wired.com/story/facebook-scandals-2018/. Accessed March 1, 2019.

25. Bickert M Combatting Vaccine Misinformation. Facebook Newsroom; 2019 https://newsroom.fb.com/news/2019/03/combatting-vaccine-misinformation/. Accessed March 11, 2019.

26. Hitlin P, Rainie L. Facebook Algorithms and Personal Data. Pew Research Center; 2019 https://www.pewinternet.org/2019/01/16/facebook-algorithms-and-personal-data/. Accessed August 16, 2019.

27. Facebook Business. About Ad Auctions. Optimization: Ad Delivery. https://www.facebook.com/business/help/430291176997542. Accessed August 19, 2019.

28. Silber T Facebook Ad-Spend Growth From National Marketers Is Slowing, Intelligence Firm's Data Shows. Forbes. 12 2018 https://www.forbes.com/sites/tonysilber/2018/12/31/facebook-ad-spend-from-national-marketers-is-slowing-intelligence-firms-data-shows/#4cebb6191591. Accessed August 19, 2019.

29. Andreou A, Silva M, Benevenuto F, Goga O, Loiseau P, Mislove A. Measuring the Facebook Advertising Ecosystem. In:; 2019.

30. Facebook Business. Advertising Policies. https://www.facebook.com/policies/ads/restricted_content. Published 2019 Accessed August 24, 2019.

31. Facebook Business. Ads about Social Issues, Elections, or Politics. Ads Help Center. https://www.facebook.com/business/help/214754279118974?helpref=page_content. Published 2019 Accessed August 24, 2019.

32. Fundamentals: Beginner's Guide. Facebook Business. https://www.facebook.com/business/help/706063442820839?helpref=page_content. Published 2019 Accessed March 4, 2019.

33. Children's Health Defense. 2019 https://childrenshealthdefense.org/. Accessed March 11, 2019.

34. Arciga J. Anti-Vaxxer Larry Cook Has Weaponized Facebook Ads in War Against Science.https://www.thedailybeast.com/anti-vaxxer-larry-cook-has-weaponized-facebook-ads-in-war-against-science. Published February 15, 2019 Accessed March 11, 2019.

35. Brunson EK, Sobo EJ. Framing childhood vaccination in the United States: Getting past polarization in the public discourse. Hum Organ. 2017;76(1):38–47.

36. Pew Research Center. Vast Majority of Americans Say Benefits of Childhood Vaccines Outweigh Risks. Pew Research Center; 2017 https://www.pewresearch.org/science/2017/02/02/vast-majority-of-americans-say-benefits-of-childhood-vaccines-outweigh-risks/. Accessed June 25, 2019.

37. Caron C. Pinterest Restricts Vaccine Search Results to Curb Spread of Misinformation. The New York Times. 2 23, 2019:A23.

38. Mnookin S. The Panic Virus: A True Story of Medicine, Science, and Fear. Simon and Schuster; 2011.

39. Facebook Ad Archive Report: US 2019/02/24 – 2019/03/02. https://www.facebook.com/ads/archive/report/. Accessed March 4, 2019.

40. Bono L. Children's Health Defense. November 2018 https://www.indiegogo.com/projects/children-s-health-defense?fbclid=IwAR1cDmf6zhzXCYQZOhecb8J-FVQ-Fp99F9sVsNPLu9PlrV_S4PYmw2v4yYU#/. Accessed March 5, 2019.

41. Dutt R, Deb A, Ferrara E. "Senator, We Sell Ads": Analysis of the 2016 Russian Facebook Ads Campaign. ArXiv180910158 Cs. 9 2018 http://arxiv.org/abs/1809.10158. Accessed September 20, 2019.

42. Washington State Department of Health. Measles 2019 https://www.doh.wa.gov/YouandYourFamily/IllnessandDisease/Measles/Measles2019. Published May 2019. Accessed June 25, 2019.

Highlights

First assessment of vaccine-related advertisements on Facebook Ad Archive.

Top pro-vaccine ad themes: vaccine promotion, philanthropy, news.

Top anti-vaccine ad themes: vaccine harm, promoting choice, uncovering "fraud".

Two buyers accounted for majority (54%) of anti-vaccine advertising content.

Facebook policies negatively impact first time ad buyers, largely pro-vaccine.

Figure 1.
Example of post with incomplete disclaimer
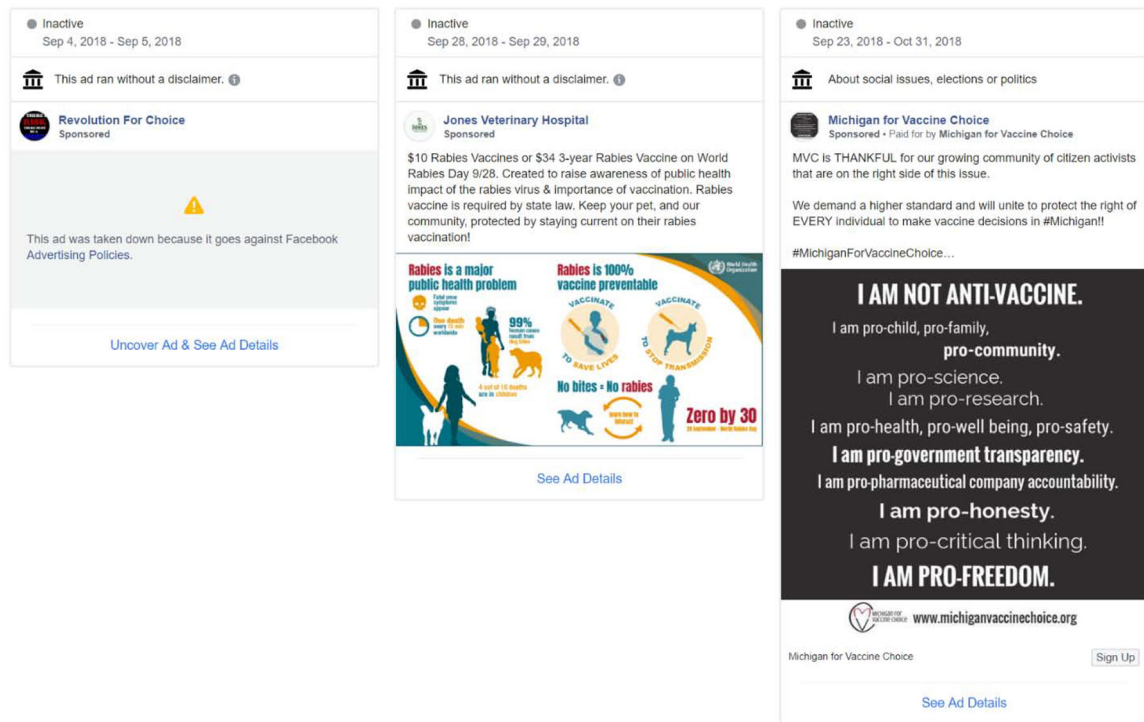
Figure 2.

Incomplete Disclaimers and Advertising Policy Violations Examples

Left: Ad with incomplete disclaimer information also flagged for "going against Facebook Advertising Policies".

Middle: Ad with incomplete disclaimer information.

Right: Ad with complete disclaimer information and "Paid for by" label.

Figure 3.
Ad Performance

Example of Ad Performance Metrics including status, impressions, money spent, age, and gender. Maps (not pictured) are also presented to demonstrate where ads were viewed.
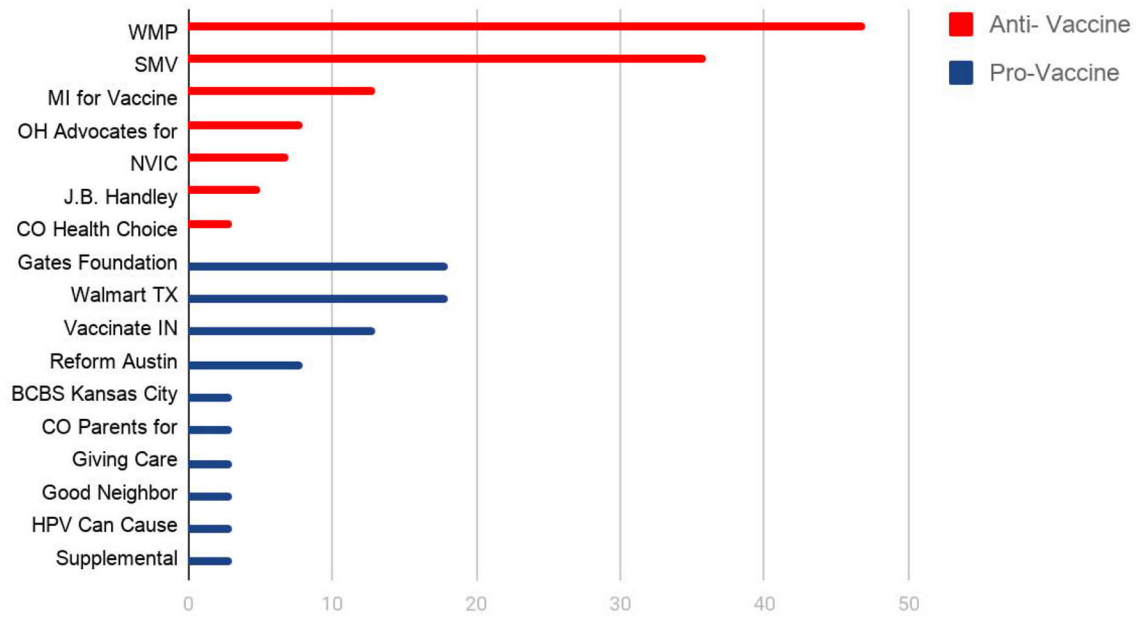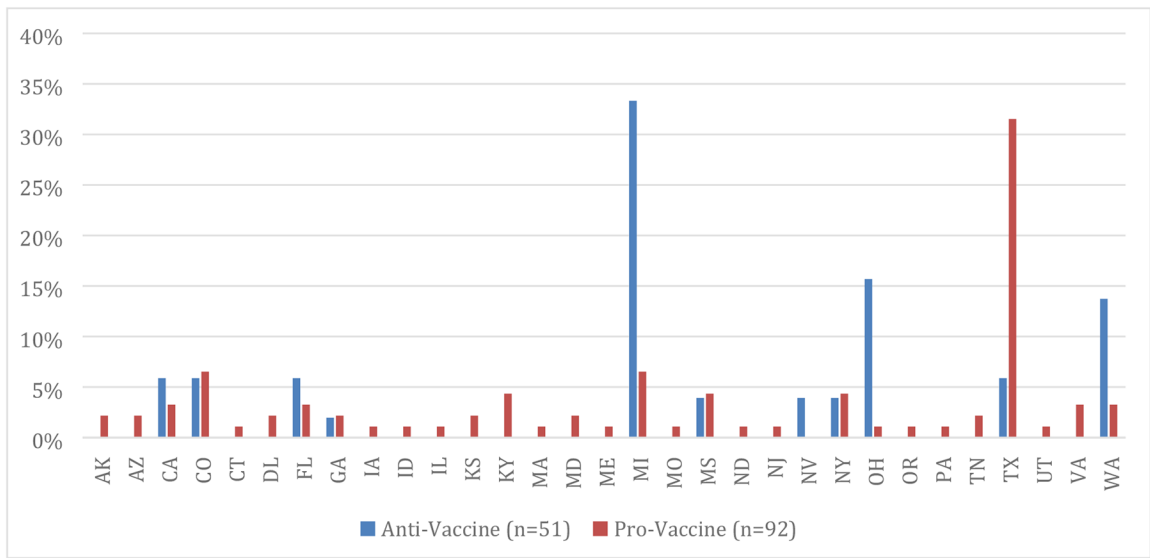
Figure 4.
Advertisements per buyer

Figure 5.
Advertisements by State

Table 1.

Ad Characteristics

	Anti-Vaccine Ads n=145	Pro-Vaccine Ads n= 163	$\chi^2(dof)$	p
Currently Active (%)	6 (4%)	13 (8%)	2.37(1)	0.12
Inactive	139 (96%)	150 (92%)		
Incomplete Disclosure	31(21%)	61 (37%)	9.43(1)	**0.002**
Complete Disclosure	114 (79%)	102 (63%)		
Taken Down	15 (10%)	10 (6%)	0.05(1)	0.18
Not Taken Down	130 (90%)	153 (94%)		
Image Only	95 (66%)	109 (67%)	0.06(1)	0.80
Includes Video	50 (34%)	54 (33%)		
Vaccination in General	119 (82%)	31 (19%)	122.11(1)	**<0.001**
Specific Vaccines	26 (18%)	132 (81%)		
Influenza	8 (31%)	52 (39%)	15.42(5)	**0.009**
HPV	3 (12%)	16 (11%)		
MMR	6 (23%)	11 (8%)		
Meningitis B	0 (0%)	18 (14%)		
Polio	1 (4%)	20 (15%)		
Other	8 (31%)	15 (12%)		
Major Themes [*] *non-discrete categories*	Vaccine Harm 72 (49%) Vaccine Choice 44 (30%) Vaccine Fraud 26 (18%)	Get Vaccinated 77(47%) Philanthropy 38 (23%) Vaccine Policy 23 (14%) News 18 (11%) Opposing Anti-Vax 17(10%)		

Boldface indicates statistical significance (p<0.05)

[*] Non-discrete categories

Table 2.

Ad Performance

	Anti-Vaccine *n=145*	Pro-Vaccine *n=163*	$\chi^2(dof)$	*p*
Total Impressions			71.42(6)	**<0.001**
<1K	21 (14%)	64 (39%)		
1K-5K	38 (26%)	40 (25%)		
5K-10K	21 (14%)	15 (9%)		
10K-50K	55 (38%)	30 (18%)		
50K-100K	4 (3%)	10 (6%)		
100K-200K	6 (4%)	1 (1%)		
> 1M	0 (0%)	3 (2%)		
Price			33.99(5)	**<0.001**
<$100[a]	80 (55%)	125 (77%)		
$100 - $499	59 (41%)	21 (13%)		
$500 - $999	4 (3%)	6 (4%)		
$1,000-$5,000	2 (1%)	8 (5%)		
$5,000-$10,000	0 (0%)	2 (1%)		
$10,000-$50,000	0 (0%)	1 (1%)		
Gender Distribution			19.04(6)	**0.004**
Entirely Female	30 (21%)	12 (7%)		
Majority Female	82 (57%)	104 (64%)		
Slightly Female	4 (3%)	13 (8%)		
About Equal	11 (8%)	15 (9%)		
Slightly Male	1 (1%)	4 (2%)		
Majority Male	17 (12%)	13 (8%)		
Entirely Male	0 (0%)	2 (1%)		
Age Distribution			27.34(4)	**<0.001**
Very Young	5 (3%)	22 (13%)		
Young Adult	83 (57%)	52 (32%)		
Middle Age Adults	24 (17%)	29 (18%)		
Older Adults	26 (18%)	38 (23%)		
Irregular	7 (5%)	22 (13%)		
GeograPhic Distribution			21.44(3)	**<0.001**
International	22 (15%)	5 (3%)		
National	70 (48%)	64 (39%)		
Regional	2 (1%)	4 (2%)		
Specific State	51 (35%)	90 (55%)		

Boldface indicates statistical significance (p<0.05)

[a] world currencies of roughly equivalent value