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# HPV vaccine-related articles shared on Facebook from 2019 to 2021: Did COVID make a difference?

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ABSTRACT

*Objective:* HPV vaccination is recommended for children beginning at age 9 to prevent several types of cancer. Many parents turn to Facebook for health information. This study describes changes in HPV vaccine-related articles shared on Facebook amidst the COVID-19 pandemic.
*Methods:* HPV-related articles shared on Facebook (2019–2021) were collected using Buzzsumo, a social media analytics tool and analyzed using content analysis. Articles were categorized by valence, misinformation, evidence types, persuasive tactics, and framing. We quantified these data and tested for difference by article year.
*Results:* Of the 138 included articles, 51% had positive valence towards the vaccine and 36% had negative valence. In 2021, there was a significant increase in positive messaging (72% vs. 44% in 2019/2020; $p < 0.01$) and misinformation decreased from 50% in 2019 to 24% in 2021 ($p = 0.04$). Persuasive strategies were more common in 2019 than in later years.
*Conclusion:* Despite decreased engagement in 2021, more positive HPV vaccine messaging was observed, although a quarter of articles still contained misinformation. Our results can inform strategies for communicating with parents about the HPV vaccine.
*Innovation:* Our study is the first to analyze HPV-related articles linked on Facebook and to assess for differences during the pandemic.

## 1. Introduction

Human papilloma virus (HPV) is a common sexually transmitted infection; approximately 85% of people in the United States will get an HPV infection in their lifetime [1,2]. HPV infections can cause several types of cancers, including oropharyngeal, cervical, anal, vulvar, and penile cancers, and approximately 37,000 people in the United States are diagnosed with a cancer caused by HPV each year [3]. The HPV vaccine was introduced in 2006 and is highly effective, with the latest version of the vaccine able to prevent over 90% of HPV-related cancers. Despite this, HPV vaccination remains suboptimal. As of 2022, only 65% of age-eligible girls and 61% of boys were fully vaccinated against HPV [4].

Vaccines are recommended for children and adolescents between the ages of 9–13, when immune response is the strongest [5]. As a result, parents are usually making HPV vaccination decisions for their children. Parents often turn to social media for health information for their children [6] [6,7], and recent studies have shown that exposure to negative vaccine information online can lead to lower vaccination rates [8]. Additionally, pro- and anti-vaccine messaging online use different types of persuasive strategies. For example, anti-HPV vaccine messages were more likely to include personal narratives [9] and ideological assertations about parents' rights to choose [10]. Facebook is the most commonly used social media platform among parents of children aged 9–14 [11]. Little is known about what is shared about HPV vaccines on Facebook, but the few studies that have been conducted indicate that many Facebook posts include inaccurate information about the risks of HPV vaccination [12,13]. No studies have yet looked at differences in

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persuasive strategies in HPV vaccine content on Facebook. All previous studies on Facebook HPV vaccine messaging were conducted with Facebook data from 2018 or earlier, and focused on the content of the posts themselves and have not evaluated the content of linked articles [12-15], which often include much more information about the HPV vaccine.

During the height of the COVID pandemic, there was a documented increase in anti-vaccine information shared online, particularly regarding the COVID vaccine [16,17]. However, it is not clear whether this anti-vaccine sentiment also extended to changes in the information shared online about the HPV vaccine. Thus, this study aims to evaluate the content of HPV vaccine information shared in Facebook posts from 2019 to 2021 and to assess potential differences before and after the COVID pandemic.

## 2. Methods

### 2.1. Data collection

HPV-related articles shared on Facebook (2019–2021) were collected using Buzzsumo, a web-crawling social media analytics platform that indexes social engagement data that has been used extensively in published social media analyses [18-21]. Articles were prioritized by engagement scores provided by Buzzsumo, defined as the total number of reactions, comments, and shares. For each of the three years, we collected 50 English-language articles with the highest engagement scores. To focus on articles with high engagement, we excluded articles with engagement scores of <1000.

### 2.2. Data management and thematic analysis

Articles were downloaded and imported into Atlas.ti Web. We used a content analysis approach to analyze the data, including coding of each article's valence, presence and type of misinformation, types of evidence provided, use of persuasive tactics, framing, and other topics included. Three authors, LAS, AM, EA, group coded five articles to create the codebook. Using the final codebook, we coded an initial subset of 20 articles for interrater reliability (Krippendorf's alpha = 0.811). Any differences were resolved through discussion and consensus. The remaining articles were then independently coded by one of the same three authors. The final codebook definitions with example quotes are displayed in Table 1.

We first coded each article at the document level for the year it was shared (2019, 2020, or 2021) and the article source (news outlet, non-profit/advocacy organization website, medical/governmental report or website, or other). We also characterized each article's overall *valence* as positive (i.e., pro-HPV vaccine), negative (i.e., anti-HPV vaccine), or mixed (i.e., containing both pro- and anti-vaccine sentiment) [22,23]. These document-level codes were mutually exclusive.

Within each article, we coded at the sentence level for the content of the article. Content codes were not mutually exclusive and the same sentence could be assigned multiple codes. We coded for any *misinformation* about the HPV vaccine. We specifically coded for each instance of misinformation related to death, neurological effects, harmful chemicals, fertility effects, and other types of misinformation. We also coded for the *types of evidence* provided in each article, including the use of statistics, references to scientific research, citing lawsuits or other laws, and links to other sources. Additionally, we coded for the use of authority figures in the articles, which typically included quotes from a named figure intended to lend weight to their arguments. Authority figure types included legal, medical, non-profit, pharmaceutical, political, public health, and scientific authority figures.

To assess the *persuasive tactics* used in the articles, we coded for the use of personal narratives, ideological assertions, fear appeals, and mistrust of institutions [9,10,24,25]. We also classified any articles that used *framing* related either to cancer prevention or sexual transmission

**Table 1**
Codebook definitions and exemplar quotes.

| Code | Definition | Example quote from articles* |
|---|---|---|
| Misinformation | | |
| Death | False statement about the HPV vaccine causing death or carrying a risk of death. | "Death risk from this vaccine according to Merck's own studies is 37 times the risk of dying from cervical cancer." (2019)<br>"The verdict is now inescapable: Gardasil is killing girls." (2020)<br>"14-Year-Old Active Girl in Wisconsin Suffers Over 300 Seizures After Gardasil Vaccine – Doctor Refuses to Consider Gardasil Cause due to Fear of Losing Research Funding." (2019, article title). |
| Neurological effects | False statement about the HPV vaccine causing severe or life-altering neurological issues. Includes brain-related conditions, seizures, etc. | "While not conclusive, the findings do spotlight potential signs of rare neurological harms that outside experts say warrant a comprehensive look at the raw data, and they paint a damning picture of how the manufacturers evaluated their products' safety." (2020) |
| Harmful chemicals | False statement about harmful chemicals being in the HPV vaccine | "However, in reality, Merck appears to have taken the precaution of removing half the aluminum from the vaccines administered to this study group. Plus, the company laced the 'placebo' with a witches' brew of other toxic chemicals." (2019) |
| Fertility effects | False statement about the HPV vaccine causing infertility or negatively affecting fertility. | "One of the hardest things for a mother to hear is your daughter will not be able to have children…People need to know these risks are very real." (2021)<br>"Clinical trial researchers for Merck, Gardasil's manufacturer, reported an explosion of reproductive injuries among the 20,000 trial volunteers. An astronomical 15% - 17% of trial participants experienced a range of reproductive harms, including premature ovarian failure." (2021) |
| Other misinformation | False statement about harmful side effects of the vaccine not in other categories or other obviously false statement about the HPV vaccine or HPV in general | "These are little children and even if there was a valid reason to give this vaccine, the effect of the vaccine would have worn off well before they were sexually active." (2019)<br>"Earlier this month (February 2019), a Mexican doctor announced that she had actually developed a cure for the Human Papilloma Virus, so the |

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**Table 1** (*continued*)

| Code | Definition | Example quote from articles* |
|---|---|---|
| | | vaccine is not even needed!" (2019) |
| Types of Evidence | | |
| Statistics | Statistics, numbers, or other statements that are presented as true that are related to the vaccine or the virus. | "More than half of adolescents ages 15 to 19 report having had oral sex, and one in 10 say they have had anal sex. Unless they are vaccinated, >80% of women become infected with HPV by age 50." (2021)<br><br>"Government numbers show a 16ˆ cancer increase in 25-year-olds, a 28% increase in 30-year-olds, several years post vaccination." (2020) |
| Scientific research | Quotes or paraphrases findings from a scientific research study. | In a study published in The BMJ in April 2021, researchers quantified the effect on cervical disease at age 20 years of immunization with the bivalent HPV vaccine at age 12–13 years in Scotland which screened women for cervical cancer from the age 20. (2021) |
| Link to another source | Includes a hyperlink to another article/post/ information source to bolster their own argument/claim. | "According to findings published in The Lancet (https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)02396-5/fulltext) medical journal, those who were vaccinated at a young age were the most protected." (2021) |
| Citing lawsuit or law | Description of an impending lawsuit or legal perspective used either in favor or against HPV vaccination. | Legislation being considered at the statehouse would require New York school children to be vaccinated against the sexually transmitted human papillomavirus (HPV), which has been linked to several types of cancer. (2020) |
| Citing authority figure | Quotes or paraphrases an authority figure as a form of evidence in favor or against the HPV vaccine. These may include scientific, medical, public health, political, legal, non-profit, or pharmaceutical authority figures. | "Dr. Vanessa Saliba, consultant epidemiologist for UKHSA, which also took part in the study, said: 'We encourage all who are eligible for the HPV vaccine to take it up when it is offered in school.'" (2021, public health authority figure)<br><br>"Dianne Harper, one of a select few specialists in OB/GYN (in the world) who helped design and carry out the Phase II and Phase III safety and effectiveness studies to get Gardasil approved has also been quite outspoken about the vaccine in the past: 'The benefit to public health is nothing, there is no reduction in cervical cancers, they are just postponed…'" (2019, medical authority figure) |
| Persuasive Tactics | | |
| Personal narrative | Includes a story, anecdote, personal testimony, etc. from an individual as a form of evidence to bolster their argument as to why someone should or shouldn't get the HPV vaccine. The story is about what happened to someone. It can be an individual talking about what happened to themself or someone else. | "If Marlena had known Gardasil was capable of causing so much damage, she never would have allowed her daughter to receive the HPV vaccine." (2021)<br><br>"One man, Jamie Rae, says he went 'to hell and back' during his treatment for throat cancer caused by the virus. 'All the things you enjoy are gone. I couldn't speak or eat for months afterwards, and I was just skeletal by the end of it,' he says. (2019) |
| Ideological assertion | The article uses a political argument to bolster their claim you should or shouldn't get vaccinated. Examples include: appeals to the importance of individual freedoms, threats to parental consent, dislike of government vaccine mandates, statements associating vaccination with a political party or orientation, statements about protecting vulnerable people, statements about the greater good/good of the community. | "As part of the country's basic vaccination schedule, parents across Costa Rica are obligated to ensure their children obtain the HPV vaccine. 'As parents, we have this possibility to protect our girls, and what better way to do it than taking advantage of this campaign?' said Dr. Daniel Salas Peraza, the Minister of Health" (2019)<br><br>"Some tweets this week called the requirement an infringement on parents' freedom and placed emphasis on the fact that HPV is sexually transmitted." (2020) |
| Fear appeal | The article makes a statement clearly intended to make readers fearful of the vaccine or the consequences of not being vaccinated. The text emphasizes the potential danger and harm that will befall individuals who do not adopt the message's recommendations. These statements could include references to death from cervical cancer, severe and life-altering side effects of the vaccine, poor health outcomes from cancer etc. | "I want to warn kids of the terrible risks for this vaccine and let other injured girls know that they are not alone. The Gardasil vaccine stole my life. Before Gardasil, my future was filled with endless possibilities." (2020)<br><br>"I have often feared that in the end babies and young children would be given the dangerous and increasingly unpopular HPV vaccines. I suspect that time is fast approaching." (2019)<br><br>"Although I've had treatment, I don't think my nightmare will ever really be over as I'll constantly be worrying if they got all the cancer or if it's come back. I would advise all girls to get vaccinated because there is proof that it works. I would also advise women to go for smear tests. It was a smear test that saved my life." (2019) |
| Mistrust of institutions | The article makes statements conveying mistrust of | "Merck knew that it was orchestrating a population- |

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**Table 1** (*continued*)

| Code | Definition | Example quote from articles* |
|---|---|---|
| | institutions such as "big pharma," government, and health authorities. Examples could include questioning the motives of the pharmaceutical companies that produce HPV vaccines, questioning the accuracy of government data about vaccine safety, questioning medical expertise, questioning the accuracy of health authorities' decisions, etc. | wide fertility experiment when it persuaded the CDC to effectively mandate Gardasil for every American teenager. Merck's pre-licensing studies predicted the current national drops in fertility." (2021)<br>"The CDC maintains a nonprofit foundation that gets enormous amounts of money from Big Pharma — including Merck, the company that produces Gardasil, the HPV vaccine." (2019) |
| Framing | | |
| Cancer prevention discourse | Frames or emphasizes the HPV vaccine as a method of cancer prevention. This does not include statements mentioning that HPV causes cancer; prevention must be mentioned or implied. | "Rates of cervical cancer dropped by 87% in women who got the vaccine when they were 12 to 13 years old." (2021)<br>"Gardasil received FDA approval in 2006 for the prevention of certain cancers and diseases caused by four HPV types." (2019) |
| STI discourse | Describes HPV transmission via sexual contact or skin-to-skin contact, or that otherwise emphasizes HPV as an STD or the HPV vaccine's connection to a sexually transmitted disease. Could include references to genital warts | "The viruses can be spread through vaginal, oral and anal sex, so are also linked to anus, penis and some head and neck cancers." (2021)<br>"HPV can only be transmitted through sexual intercourse and our government is calling for kids to be injected with this vaccination by the age of 9!" (2019) |
| Topics Included | | |
| School related discourse | Any mention of schools mandating or encouraging HPV vaccination. Do not use this code when the text references school-aged children only. | "A new proposed bill in New York would mandate the HPV Gardasil vaccine as a requirement for school attendance, both private and public, including daycare." (2019)<br>"HPV16 and 18, two of the most high-risk cancer-causing types of human papillomavirus, have been almost eliminated from young women in England thanks to the introduction of a mass vaccination program in school." (2020) |
| Religious discourse | The article includes language about religion (example, religious beliefs that sex should be saved for marriage) | "A representative of Campaign Life Coalition, Canada's biggest anti-abortion group, told trustees the HPV vaccine 'undermines the Church's teaching that sex should be reserved for marriage and sends the wrong message to young girls.'" (2019) |
| COVID | The article makes mention of COVID-19. | "Moreover, with a COVID-19 vaccine now approved, it's more essential than ever to openly discuss the pros and cons of vaccination, given that 'we are more awake as a society to the evils of the pharmaceutical industry,' which has an obvious incentive to push a mandatory coronavirus vaccine, Owens said in video posted Tuesday on Instagram." (2020) |

* Coding was not mutually exclusive. Many of the included quotes were cross-coded with other codes.

of the virus. Previous studies have found that framing HPV vaccination as cancer prevention, rather than discussing sexual transmission or symptoms, is associated with vaccine acceptance [26,27].

Finally, we coded for *other topics* known to be common to HPV vaccine-related discourse including religion, school-related discourse (e.g., whether it is a school-required vaccine) [10], and due to our research question, we coded for any mention of COVID.

We reported all counts and percentages at the document level and used chi-square and Fischer's exact tests to look at differences in percentages across the three years. All quantitative analyses were conducted in SPSS version 29 with a predetermined alpha = 0.05.

## 3. Results

### 3.1. Article sources and engagement

Our total sample included 138 articles, as only 38 articles in 2021 had engagement scores of over 1000. Facebook engagement scores for included articles ranged from 1095 to 236,841 reactions, comments, or shares. Articles were most commonly shared from news or media sites (46%), but also came from non-profit/advocacy group sites (13%), governmental or hospital-based websites (7%). Other types of sites (44%) included personal blogs and other websites that did not fit one of the above categories. Fourteen of the 19 articles from non-profit/advocacy groups were from the Children's Health Defense group, chaired by Robert F. Kennedy, which is known primarily for anti-vaccine messaging. News and media site were varied and included both U.S. and international news outlets, at both national and local levels.

### 3.2. Article valence

In total, just over half of the articles had positive valence ($n = 72$; 52%), over a third had negative valence ($n = 49$; 36%), and 13% ($n = 18$) had mixed valence (Table 2). Mixed perspective articles gave voice to both pro- and anti-vaccine perspectives, without weighing in on the accuracy of either perspective's claims or without correcting misinformation. For example, one mixed-perspective article from 2020 included the following pro-vaccine message,

> "A study published last year in the journal The Lancet indicates that the HPV vaccine could eliminate cervical cancer. Researchers who reviewed 65 studies in 14 high-income countries found that since the vaccine was introduced in 2006, there has been a 'substantial' decrease in HPV infections and related conditions."

The same article also included anti-vaccine sentiments without correcting the misinformation:

> "But the vaccine has been controversial for many years, both because of concerns about side effects and because of concerns that it could lead to early sexual activity."

**Table 2**
Number and percent of articles containing each code, by article year.

| | TOTAL | | 2019 | | 2020 | | 2021 | | Chi-square† |
|---|---|---|---|---|---|---|---|---|---|
| | (*n* = 138) | | (*n* = 50) | | (n = 50) | | (*n* = 38) | | *p*-value |
| | n | % | n | % | n | % | n | % | |
| Article Source* | | | | | | | | | †**0.01** |
| News outlet | 64 | 46% | 24 | 48% | 19 | 38% | 21 | 55% | |
| Advocacy organization | 18 | 13% | 3 | 6% | 7 | 14% | 8 | 21% | |
| Government or medical publication | 10 | 7% | 1 | 2% | 8 | 16% | 1 | 3% | |
| Other | 46 | 33% | 22 | 44% | 16 | 32% | 8 | 21% | |
| Article Valence* | | | | | | | | | **0.004** |
| Positive | 71 | 51% | 22 | 44% | 22 | 44% | 27 | 71% | |
| Negative | 49 | 36% | 22 | 44% | 16 | 32% | 11 | 29% | |
| Mixed | 18 | 13% | 6 | 12% | 12 | 24% | 0 | 0% | |
| Misinformation (any) | 56 | 41% | 25 | 50% | 22 | 44% | 9 | 24% | 0.37 |
| Death | 30 | 22% | 16 | 32% | 12 | 24% | 2 | 5% | **0.01** |
| Neurological effects | 26 | 19% | 9 | 18% | 11 | 22% | 6 | 16% | 0.75 |
| Harmful chemicals | 14 | 10% | 6 | 12% | 5 | 10% | 3 | 8% | †0.94 |
| Fertility effects | 10 | 7% | 5 | 10% | 2 | 4% | 3 | 8% | †0.60 |
| Other misinformation | 50 | 36% | 23 | 46% | 18 | 36% | 9 | 24% | 0.98 |
| Types of Evidence | | | | | | | | | |
| Statistics | 102 | 74% | 41 | 82% | 34 | 68% | 27 | 71% | 0.25 |
| Scientific research | 79 | 57% | 24 | 48% | 29 | 58% | 26 | 68% | 0.16 |
| Link to another source | 109 | 79% | 43 | 86% | 36 | 72% | 30 | 79% | 0.23 |
| Citing lawsuit or law | 50 | 36% | 21 | 42% | 19 | 38% | 10 | 26% | 0.30 |
| Citing authority figure | 124 | 90% | 50 | 100% | 43 | 86% | 31 | 82% | 0.08 |
| Persuasive Tactics | | | | | | | | | |
| Personal narrative | 40 | 29% | 19 | 38% | 8 | 16% | 13 | 34% | **0.04** |
| Ideological assertion | 36 | 26% | 18 | 36% | 17 | 34% | 1 | 3% | **<0.001** |
| Fear appeal | 41 | 30% | 21 | 42% | 9 | 18% | 11 | 29% | **0.03** |
| Mistrust of institutions | 42 | 30% | 26 | 52% | 10 | 20% | 6 | 16% | **<0.001** |
| Framing | | | | | | | | | |
| Cancer prevention discourse | 97 | 70% | 31 | 62% | 38 | 76% | 28 | 74% | 0.27 |
| STI discourse | 72 | 52% | 24 | 48% | 27 | 54% | 21 | 55% | 0.64 |
| Topics Included | | | | | | | | | |
| School related discourse | 42 | 30% | 19 | 38% | 17 | 34% | 6 | 16% | **0.06** |
| Religious discourse | 5 | 4% | 4 | 8% | 1 | 2% | 0 | 0% | †0.14 |
| COVID | 4 | 3% | 0 | 0% | 1 | 2% | 3 | 8% | †0.10 |

* Article Source and Valence categories are mutually exclusive. All other codes are not mutually exclusive.
† Fischer's exact tests were used for variables in which there were cells with expected counts of less than five.

We found differences in valence over the three years, with 44% of articles being categorized as positive in 2019 and 2020, compared to 71% positive in 2021 ($p = 0.004$; Table 2).

### 3.3. Misinformation

In total, 41% of the articles ($n = 56$) contained some type of misinformation (Table 2). This was driven in part by differences in article valence, with 6% of positive valence articles, compared to 90% of negative valence articles containing misinformation ($p < 0.001$). We also saw a substantial difference in the overall distribution of misinformation by year, with 50% of articles in 2019 containing misinformation, compared to 44% in 2020 and only 24% in 2021 ($p = 0.04$). Common sources of misinformation included linking HPV vaccines to: neurological side effects ("14-Year-Old Active Girl in Wisconsin Suffers Over 300 Seizures After Gardasil Vaccine." (2019)), death ("The verdict is now inescapable: Gardasil is killing girls." (2020)), and infertility ("It's outrageous that a vaccine that robs women of the chance to have children…continues to be pushed on the masses." (2019)). All types of misinformation decreased in 2021 compared to previous years, but only misinformation linking the HPV vaccine to death reached statistical significance (5% in 2021 compared to 32% in 2019 and 24% in 2020; $p = 0.01$). Examples of other types of misinformation are shown in Table 1.

### 3.4. Types of evidence

Most articles (90%) referenced some type of authority figure. Overall, the most commonly cited authority figures were public health authority figures (used in 75% of all articles), scientific authority figs. (37%), and medical authority figs. (25%). The use of these authority figures decreased each year, but was not statistically significant ($p = 0.08$). The next most common type of evidence used was links to other sources (used in 79% of all articles), followed by statistics (in 74%) and references to scientific literature (59%). The types of evidence used did not differ by year.

### 3.5. Persuasive strategies

Prevalence of persuasive strategies (personal narratives, ideological assertions, fear appeals, and promoting mistrust of institutions) was greater in 2019 than in later years. For example, 52% of articles shared in 2019 promoted mistrust of institutions ("If you're a pediatrician I would ask you to actually look at the science and not resort to appeals to authority because…all of those agencies and organizations have been corrupted by pharmaceutical industry money.") versus 20% of articles in 2020 and 15% in 2021 ($p < 0.001$). Both fear appeals and personal narratives were most heavily used in 2019 (42% and 38%, respectively), and least used in 2020 (18% and 16%, respectively). Fear appeals were most often used in negative vaccine sentiments, such as, "I want to warn kids of the terrible risks for this vaccine and let other injured girls know that they are not alone. The Gardasil vaccine stole my life. Before Gardasil, my future was filled with endless possibilities." (2020) However, eight positive-valence articles also contained fear appeals. One example from 2021 included the following, "I just think that if [the HPV vaccine] existed when I was a teenager, I wouldn't be dying now and my son wouldn't be facing a future as an orphan." Both of these quotes are also examples of personal narratives.

Finally, ideological assertions were used significantly less often in 2021 (3%) compared to past years (34–36%, $p < 0.001$). Most ideological assertions related to limiting parental choice about the HPV vaccine. For example, an article in 2019 included this quote from a parent, "The vaccine should be made a CHOICE – not mandatory. I respect your decision to vaccinate, please respect my right to choose."

### 3.6. Framing

In regards to framing, 70% of total articles discussed the HPV vaccine in terms of cancer prevention and 52% mentioned the sexually transmitted nature of the virus. An example of cancer prevention framing included, "More than 100 countries have started using the vaccine as part of the World Health Organization plans to get close to eliminating cervical cancer," (2021) and, "Without a doubt, the HPV vaccine prevents cancer." (2020). An example of sexual transmission discourse in a negative valence article from 2019: "HPV can only be transmitted through sexual intercourse and our government is calling for kids to be injected with this vaccination by the age of 9!" Sexual transmission discourse was also seen in positive valence articles such as this one from 2021, "The HPV vaccine can only prevent an infection, it cannot rid the body of the virus once it has been caught. The viruses are so widespread that immunisation has to be aimed at children before they become sexually active." Framing did not differ by year the article was shared (Table 2).

### 3.7. Other topics

Finally, we found that 30% of total articles included school-related discourse and only 4% included religious discourse. School-related information decreased from 38% in 2019 to 16% in 2021. A common type of school-related discourse is exemplified by the following quote from a 2019 article: "A New York State bill will mandate school children to get the HPV vaccine to attend public school if it passes." COVID was only mentioned in four total articles, once in 2020 and in 3 articles in 2021. An example from 2021 included the following, "Vaccine hesitancy is hardly limited to shots against Covid-19. Even the HPV vaccine, which can prevent as many as 90 percent of six potentially lethal cancers, is meeting with rising resistance from parents who must give their approval before their adolescent children can receive it."

## 4. Discussion and conclusion

### 4.1. Discussion

Our study investigated engagement with HPV-related articles shared on Facebook before and during the COVID-19 pandemic. We aimed to assess changes in the types of information shared, presence of misinformation, and persuasive strategies used across the articles. Our results indicate a notable decrease in engagement with HPV-related articles in 2021 compared to prior years, coinciding with the emergence of the COVID-19 pandemic. This decline in engagement may be reflective of a general shift in focus towards COVID-related health news. The World Health Organization refers to this time as an "infodemic" where too much health information shared online can cause confusion and "digital overload" among the public [28,29]. This may result in other important health topics, such as HPV, being crowded out.

Importantly, we saw a shift in the valence of HPV-related articles engaged with on Facebook across the years. Despite reduced engagement overall, the articles shared in 2021 were more likely to be pro-vaccine and contained less misinformation than those shared in the preceding years. One explanation for this shift may be that those who commonly share and interact with vaccine misinformation or anti-vax content online were focused on the COVID vaccine in 2021, leaving less time to engage around HPV. A 2021 report from the Center for Countering Digital Hate found that just 12 individuals, dubbed "the Disinformation Dozen" were responsible for over 65% of all COVID anti-vaccine content shared online and over 73% of COVID anti-vaccine shared on Facebook, specifically [30]. One of the "Dozen" named individuals in that report, Robert F. Kennedy, authored or was referenced more often in earlier articles, perhaps reflecting a shift in his and other anti-vaxxers' attention from HPV to the COVID vaccine. Our longitudinal findings highlight the influence that a few key opinion leaders can have, either positively or negatively, on vaccine information engaged with online.

In December 2020, in response to an influx of misinformation about the COVID vaccine online, Facebook announced that it would remove posts with false claims about the COVID-19 vaccine and suspend accounts that repeatedly posted misinformation [31]. In February 2021, this policy was extended to all vaccine misinformation, including that related to the HPV vaccine [32]. While this may, in part, explain the decrease in anti-vax materials shared on Facebook in 2021, a 2023 study focused on COVID-related vaccine messages on Facebook found that that both anti- and pro-vaccine messages decreased over time, but engagement with anti-COVID vaccine content remained the same or even exceeded levels prior to the new policies [33].

Despite this decrease in anti-vax articles shared on Facebook in 2021, it is critical to note that almost a quarter of articles shared in that year included misinformation, and thus many parents are still exposed to HPV vaccine misinformation. A similar study assessing HPV vaccine messaging on Twitter from 2019 to 2021 found that HPV vaccine messaging among those in vaccine hesitant groups increased after the start of the pandemic, while messaging from those in HPV vaccine confident groups decreased [34]. This is important given that a 2017 population-based study found that exposure to negative HPV vaccine information on social media has been shown to help explain differences in HPV vaccination coverage not explained by socio-demographic variables [35].

Our study results should be considered in light of several limitations. Due to changes in Facebook privacy policies, we cannot assess the text of the posts that shared the articles in our dataset or the comments made by other Facebook users. We also do not have any information on the demographic information of those who interacted with (i.e., liked, commented, or shared) the Facebook posts linking these articles. However, given that Facebook is the most commonly used social media platform among parents of children aged 9 to 14 [11], this analysis fills a critical gap in understanding the type of HPV vaccine messaging that parents may be exposed to on the site.

### 4.2. Innovation

This study represents the only analysis of HPV-related articles shared on Facebook. Given that Facebook is the most commonly used social media platform of parents of children ages 9 to 14, it is critical that we understand what information and misinformation they are exposed to there in order to combat misperceptions and increase coverage of this cancer-preventing vaccine. Furthermore, previous studies of HPV-related Facebook posts were conducted using data from 2018 or earlier and ours is the first to look at changes in engagement with HPV-related articles during the COVID-pandemic.

## 5. Conclusion

Our study the documents the changes in engagement and content of HPV-related content shared on Facebook during the COVID-19 pandemic. The results underscore both challenges and opportunities for improving health information efforts around HPV vaccination. Our results can inform strategies for communicating with parents about the HPV vaccine, by anticipating the quality of information parents may have encountered online.

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## CRediT authorship contribution statement

**L. Aubree Shay:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ashley McKenzie:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Elaine Avshman:** Writing – review & editing, Formal analysis. **Lara S. Savas:** Writing – review & editing, Funding acquisition. **Ross Shegog:** Writing – review & editing, Funding acquisition.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

[1] Centers for Disease Control and Prevention, (CDC). HPV Vaccine Schedule and Dosing2023. CDC; 2024. https://www.cdc.gov/hpv/hcp/schedules-recommendations.html (accessed 27 February 2024).
[2] Centers for Disease Control and Prevention, (CDC). Why Get the HPV Vaccine, 2024. https://www.cdc.gov/hpv/parents/vaccine/six-reasons.html; 2022 (accessed 27 February 2024).
[3] Centers for Disease Control and Prevention, (CDC). How Many Cancers Are Linked with HPV Each Year?2024. CDC; 2023. https://www.cdc.gov/cancer/hpv/statistics/cases.htm (accessed 01 February 2024).
[4] Pingali C, Yankey D, Elam-Evans LD, Markowitz RE, Valier MR, Fredua B, et al. National Vaccination Coverage Among Adolescents Aged 13-17 Years - National Immunization Survey-Teen, United States, 2021, MMWR Morb. Mortal Wkly Rep 2022;71:1101–8.
[5] St Sauver JL, Rutten LJF, Ebbert JO, Jacobson DJ, McGree ME, Jacobson RM. Younger age at initiation of the human papillomavirus (HPV) vaccination series is associated with higher rates of on-time completion. Prev Med 2016;89:327–33.
[6] Melovic B, Jaksic Stojanovic A, Vulic TB, Dudic B, Benova E. The impact of online media on Parents' attitudes toward vaccination of children-social marketing and public health. Int J Environ Res Public Health 2020;17:5816. https://doi.org/10.3390/ijerph17165816.
[7] Ashfield S, Donelle L. Parental online information access and childhood vaccination decisions in North America: scoping review. J Med Internet Res 2020;22:e20002.
[8] Ortiz RR, Smith A, Coyne-Beasley T. A systematic literature review to examine the potential for social media to impact HPV vaccine uptake and awareness, knowledge, and attitudes about HPV and HPV vaccination. Hum Vaccin Immunother 2019;15:1465–75.
[9] Massey PM, Kearney MD, Hauer MK, Selvan P, Koku E, Leader AE. Dimensions of misinformation about the HPV vaccine on Instagram: content and network analysis of social media characteristics. J Med Internet Res 2020;22:e21451.
[10] Keelan J, Pavri V, Balakrishnan R, Wilson K. An analysis of the human papilloma virus vaccine debate on MySpace blogs. Vaccine 2010;28:1535–40.
[11] Manganello JA, Chiang SC, Cowlin H, Kearney MD, Massey PM. HPV and COVID-19 vaccines: social media use, confidence, and intentions among parents living in different community types in the United States. J Behav Med 2023;46:212–28.
[12] Sundstrom B, Aylor E, Cartmell KB, Brandt HM, Bryant DC, Hughes Halbert C, et al. Beyond the birds and the bees: a qualitative content analysis of online HPV vaccination communication. J Commun Healthc 2018;11:205–14.
[13] Luisi MLR. From bad to worse II: risk amplification of the HPV vaccine on Facebook. Vaccine 2021;39:303–8.
[14] McGeechan GJ, James B, Burke S. 'Well that's the most ridiculous thing I have ever heard! No excuse'. A discourse analysis of social media users' othering of non-attenders for cervical screening. Psychol Health 2021;36:290–306.
[15] Hale TM, Pathipati AS, Zan S, Jethwani K. Representation of health conditions on Facebook: content analysis and evaluation of user engagement. J Med Internet Res 2014;16:e182.
[16] Durmaz N, Hengirmen E. The dramatic increase in anti-vaccine discourses during the COVID-19 pandemic: a social network analysis of twitter. Hum Vaccin Immunother 2022;18:2025008.
[17] Ngai CSB, Singh RG, Yao L. Impact of COVID-19 vaccine misinformation on social media Virality: content analysis of message themes and writing strategies. J Med Internet Res 2022;24:e37806.
[18] Moscadelli A, Albora G, Biamonte MA, Giorgetti D, Innocenzio M, Paoli S, et al. Fake news and Covid-19 in Italy: results of a quantitative observational study. Int J Environ Res Public Health 2020;17:5850. https://doi.org/10.3390/ijerph17165850.
[19] Shoureshi PS, Rajasegaran A, Kokorowski P, Sparks SS, Seideman CA. Social media engagement, perpetuating selected information, and accuracy regarding CA SB-201: treatment or intervention on the sex characteristics of a minor. J Pediatr Urol 2021;17:372–7.
[20] Obiala K, Obiala J, Manczak M, Owoc J, Olszewski R. Type and reliability of information about coronavirus most frequently shared by social media users. Health Policy Technol 2022;11:100626.
[21] Rasouli MA, Sagun BK, Verma K, Duke CM. Black infertility and social media engagement: a mixed methodology analysis. F S Rep 2021;3:55–61.
[22] Ruiz JB, Bell RA. Understanding vaccination resistance: vaccine search term selection bias and the valence of retrieved information. Vaccine 2014;32:5776–80.
[23] Xin M, Luo S, Wang S, Zhao J, Zhang G, Li L, et al. The roles of information valence, media literacy and perceived information quality on the association between frequent social media exposure and COVID-19 vaccination intention. Am J Health Promot 2023;37:189–99.
[24] Madden K, Nan X, Briones R, Waks L. Sorting through search results: a content analysis of HPV vaccine information online. Vaccine 2012;30:3741–6.
[25] Chen L, Ling Q, Cao T, Han K. Mislabeled, fragmented, and conspiracy-driven: a content analysis of the social media discourse about the HPV vaccine in China. Asian J Commun 2020;30:450–69.
[26] McRee A, Reiter PL, Chantala K, Brewer NT. Does framing human papillomavirus vaccine as preventing cancer in men increase vaccine acceptability? Cancer Epidemiol Biomarkers Prev 2010;19:1937–44.
[27] Leader AE, Weiner JL, Kelly BJ, Hornik RC, Cappella JN. Effects of information framing on human papillomavirus vaccination. J Womens Health 2009;18:225–33.
[28] Banerjee D, Meena KS. COVID-19 as an "Infodemic" in public health: critical role of the social media. Front Public Health 2021;9:610623.
[29] Wilhelm E, Ballalai I, Belanger M, Benjamin P, Bertrand-Ferrandis C, Bezbaruah S, et al. Measuring the Burden of Infodemics: Summary of the Methods and Results of the Fifth WHO Infodemic Management Conference. JMIR Infodemiol 2023;3:e44207.
[30] Center for Countering Digital Hate. Report: The disinformation dozen. https://counterhate.com/wp-content/uploads/2022/05/210324-The-Disinformation-Dozen.pdf; 2021 (accessed 26 February 2024).
[31] Jin K.-X. Keeping people safe and informed about the coronavirus. Meta. [accessed 28 May 2024]. https://about.fb.com/news/2020/12/coronavirus/; 2020.
[32] Reaching billions of people with COVID-19 vaccine information. Meta. https://about.fb.com/news/2021/02/reaching-billions-of-people-with-covid-19-vaccine-information/; 2021.
[33] Broniatowski B, Simons S, Gu G, Jamison J, Abroms A. The efficacy of Facebook's vaccine misinformation policies and architecture during the COVID-19 pandemic. Sci Adv 2023;9. eadh2132.
[34] Boucher J, Kim SY, Jessiman-Perreault G, Edwards J, Smith H, Frenette N, et al. HPV vaccine narratives on twitter during the COVID-19 pandemic: a social network, thematic, and sentiment analysis. BMC Public Health 2023;23:694–w.
[35] Dunn AG, Surian D, Leask J, Dey A, Mandl KD, Coiera E. Mapping information exposure on social media to explain differences in HPV vaccine coverage in the United States. Vaccine 2017;35:3033–40.