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The role of media and the Internet on vaccine adverse event reporting: a case study of HPV vaccination

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Abstract

Purpose—This study aimed to determine the temporal association of print media coverage and Internet search activity with adverse events reports associated with the human papillomavirus vaccine Gardasil® (HPV4) and the meningitis vaccine Menactra® (MNQ) among U.S. adolescents.

Methods—We used moderated linear regression to test the relationships between print media reports in top circulating newspapers, Internet search activity, and reports to the Vaccine Adverse Event Reporting System (VAERS) for HPV4 and MNQ during the first 2.5 years post-FDA approval.

Results—Compared to MNQ, HPV4 had more coverage in the print media and Internet search activity, which corresponded with the frequency of VAERS reports. In February 2007, we observed a spike in print media for HPV4. Although media coverage waned, Internet search activity remained stable and predicted the rise in HPV4-associated VAERS reports.

Conclusions—We demonstrate that media coverage and Internet search activity, in particular, may promote increased adverse event reporting. Public health officials who have long recognized the importance of proactive engagement with news media must now consider strategies for meaningful participation in Internet discussions.

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Keywords

Vaccine Adverse Event Reporting System (VAERS); Papillomavirus Vaccines; Meningococcal Vaccines; Mass Media; Newspapers; Internet

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Introduction

In June 2006, the United States Food and Drug Administration (FDA) approved Gardasil® (Merck & Co., Inc.), a quadrivalent recombinant vaccine that prevents certain strains of human papillomavirus (HPV) which can cause genital warts and are linked with the development of cancers including cervical cancer (1). Though Gardasil® (“HPV4”) was lauded as a medical breakthrough, the social and political climate surrounding vaccination was tumultuous due to questionable lobbying practices and conflicts of interest, anecdotal reports of side effects, and public debate about parental rights and adolescent sexual practices.

The HPV vaccine differs from other childhood vaccinations in ways that the public found salient (2). First, the FDA initially approved the vaccine for use only in females aged 9–26; so vaccine recommendations were gender specific, unlike other vaccines on the market. This targeting was purposeful in an effort to reduce the future burden of cervical cancer in women; however, it was also perceived as biased, since males are also able to be infected and transmit the virus. Second, legislation was introduced in several states to mandate HPV vaccine education and/or vaccination in middle school-aged girls (3), a period when the likelihood of HPV exposure is low (and thus, vaccination most effective for prevention) and other adolescent vaccines are administered. The first such legislation was introduced by Texas Governor Rick Perry in February 2007. Gov. Perry issued an executive order (4) that school girls over the age of 11 should be vaccinated against HPV—a mandate that received substantial national news coverage though it was quickly overturned by the Texas legislature following parental outcry and political descant on the issue of parental rights. Most states that had similar bills under consideration were tabled, withdrawn, or vetoed soon thereafter. Third, the sexually transmitted nature of HPV garnered a great deal of media attention, differentiating it from diseases that can be transmitted by casual contact in the classroom (e.g., measles, mumps, whooping cough) (5). Talking points about adolescent promiscuity and premarital sex were also present in the media (5) and distracted viewers from the primary messages about cervical cancer and prevention of sexually-transmitted infections being presented by health professionals.

As the discourse unfolded, reports of HPV4-associated adverse events escalated on the Vaccine Adverse Events Reporting System (VAERS) maintained by the U.S. Centers for Disease Control and Prevention (CDC) and the FDA. Slade et al. (6) found that the VAERS reporting rate for HPV4 was triple the rate for all other vaccines combined from 6/1/2006–12/31/2008, citing a possible “Weber effect” – where reporting of adverse events spikes following the licensure of a new product. In his work from the 1980s, Weber described how the adverse event reporting rate can be influenced by factors such as exposure to a new treatment, new dosage forms, and exposure to journal articles or regulatory agency warnings (7). With the widespread availability of health-related information in the news print and online media, some have suggested that biased reporting can also be due to “increased reporting after publicity about a particular known or alleged type of adverse event” (8).

Studies have long evaluated the effect of news media reports on knowledge (9) and risk perceptions (10). Kelly et al. (9) found that HPV-associated knowledge levels increased as media coverage increased, and found that knowledge remained high even as media coverage

levels dwindled over time. This suggests that once gained, knowledge stays; conversely, perhaps information propagates on other sources (e.g., Internet). Ball et al. (10) also mentions the role of media outlets in molding the publics' perceptions of vaccine risk. To our knowledge, however, we know of no studies that have quantified the association of print media with the frequency of adverse event reports to VAERS.

The current study aimed to determine the temporal association of print media and HPV4-associated VAERS reports among adolescents in the U.S. We also examined the mediating effect of Internet search activity. We conducted the same analyses for Menactra® (Sanofi Pasteur, Inc.; "MNQ"), a meningococcal vaccine licensed for a similar age group just 18 months prior to HPV4, as a comparison case. We hypothesized that: 1) the increased media coverage surrounding HPV4 in the initial period following FDA approval would be associated with an increased number of HPV-associated VAERS reports, and 2) the number of HPV-associated VAERS reports would remain steady despite waning print media coverage over time due to continued public interest in HPV vaccination as evidenced by Internet search activity.

Methods

Data Sources and Procedures

Multiple data sources were included in our analysis including the monthly total of adverse event reports from VAERS, the monthly total of print media reports from top-circulating U.S. newspapers, and the monthly frequency of Internet search activity as measured by Google Insights for Search beta. The public availability and de-identified nature of the data received from these sources did not necessitate institutional review.

VAERS is a post-marketing, passive vaccine safety surveillance system established in the 1990s to collect and analyze data on reported adverse events following the administration of U.S.-licensed vaccines (11). Anyone can report an adverse event, including health care providers, vaccine manufacturers, and the public. Medical events are encouraged to be reported, even if the reporter is unsure whether there is a causal link between vaccination and the event, and selected reports will be followed-up by VAERS staff. Over 85% of all the reports received are mild and include fever, injection site reactions, and irritability (12). Publicly-available data from 2005–2008 were retrieved from the VAERS website (<http://vaers.hhs.gov/data/data/>) in early 2009. We included VAERS reports from June 2006–December 2008 for HPV4 and from January 2005–July 2007 for MNQ. The abbreviations HPV4 and MNQ are the respective terms used by VAERS for Gardasil® and Menactra®. The dates we chose correspond to approximately 2.5 years after initial FDA approval of each vaccine. VAERS data were only extracted for adolescents aged 11–18 years, as this range falls within the Advisory Committee on Immunization Practices' recommended age of vaccination for both vaccines (i.e., HPV4: 11–26 years and MNQ: 11–18 years) (13,14). VAERS reports that had both MNQ and HPV listed in the sample report were excluded (n=1,160).

We searched LexisNexis, the largest database of public-record news articles, for print media reports from top circulating U.S. newspapers (top 20) or top largest U.S. cities (top 10). Five newspapers unavailable through LexisNexis were not included. A total of 16 newspapers were analyzed (see Appendix for list).

We limited our document search to the time periods June 2006–December 2008 for print media reports related to HPV4 and January 2005–July 2007 for those related to MNQ, so that they would also correspond to the 2.5 years after initial FDA approval of each vaccine. The following search terms were used to identify print media reports related to HPV4:

“HPV” AND “vaccine OR vaccination OR immunization”; “Human papillomavirus” AND “vaccine OR vaccination OR immunization”; “Gardasil.” For those related to MNQ, we used the following search terms: “Menactra”; “Meningococcal” AND “vaccine OR vaccination OR immunization”; “Meningitis” AND “vaccine OR vaccination OR immunization.” We did not specifically search for the terms HPV4 or MNQ because these are abbreviations used by VAERS, not the media or public. We excluded reports related solely to Merck or Sanofi Pasteur’s financial status (e.g. profits) and duplicate reports from the monthly count. We did not exclude reports that fit the search criteria, but were only tangentially related to HPV4 or MNQ (e.g., articles mentioning Cervarix® or Prevnar®). However, we noted very few reports that met this criterion (e.g., Cervarix® and Prevnar® were approved outside our study timeframe).

Monthly Internet search activity was measured using Google Insights for Search (now Google Trends), a web tool published by Google Inc. that shows the popularity of specific search terms entered into Google Search. The tool analyzes a sample of Google web searches to calculate how many searches have been conducted on your topic of interest relative to the total number of searches conducted. Repeated queries on a particular topic from a single user over a short time span are not included to minimize potential bias. Google Insights data are graphically displayed over time and space. Specific news headlines on that particular topic can also be plotted, to give the viewer a better sense of what may be driving the popularity of search terms over time. We searched for the terms “Gardasil” and “Menactra” and extracted the monthly total search popularity (normalized across geographic regions and scaled by Google from 0–100) for analysis. More details on the methods used to derive the data are available online (<http://support.google.com/trends>; Site Help Section).

Data Analysis

Descriptive statistics were used to summarize news media reports, VAERS reports, and Internet search activity. T-tests measured mean differences between key variables by vaccine type. A moderated regression model was used to assess whether the spike in print media reports observed in month-9 after FDA approval of HPV4 (which coincided temporally with Gov. Perry’s HPV4 mandate) was significantly different than the preceding and subsequent months (15). This model also controlled for continuous time, to ensure a clean estimate of our categorical construction of time (months 1–8, month 9, months 10–31). We ran two additional moderated regression models to examine the differences in VAERS reports between HPV4 and MNQ over time and by Internet search activity. In these models, we also controlled for continuous time and the number of monthly print media reports. Significant interaction effects were deconstructed to identify the specific differences between HPV4 and MNQ over time and by Internet search activity. Mediations tests were conducted using Sobel statistics (16). JMP 9.0 for Mac was used to conduct all of these described statistical tests.

Results

Summary of VAERS and print media reports

In the initial 2.5 years post-FDA licensure, there were 1,220 MNQ- and 5,040 HPV4-associated adverse events reported to VAERS that met our inclusion and exclusion criteria. The monthly mean number of HPV4-associated VAERS reports was 159.19 ($SD=92.55$), which was significantly greater ($t(60)=6.96$, $p<.001$) than MNQ-associated VAERS reports ($M=18.77$, $SD=28.34$). In the 2.5 years post-FDA licensure, we identified 582 and 249 unique news reports published in top circulating U.S. newspapers related to the HPV4 and MNQ vaccines, respectively. The mean monthly number of print media reports was significantly greater for HPV4 ($M=18.77$, $SD=28.3$) compared to MNQ ($M=8.03$, $SD=3.26$),

($t(60)=2.09, p=.04$). This t -test was inclusive of month-9, where print media coverage spiked (147 reports in month-9; $z\text{-score}=4.52$).

Print media reports varied across time and by vaccine type

This prompted us to test if this specific month was individually different than the 8 preceding and 22 subsequent months. To do this, we ran a moderated regression model (bottom of Figure 1) where the number of print media reports was regressed on the interaction between vaccine type and spike-level. The model was significant ($F(6, 55)=28.50, p<.0001, R^2=.76$) and the interaction term improved the fit of the model ($F(2, 55)=36.07, p<.0001, \Delta R^2=.32$). A stratified analysis revealed no significant differences in print media reports over time periods for MNQ, while HPV4 had a significant, positive slope before the spike ($t(56)=6.96, p<.0001, \beta=.58$) and a significant, negative slope afterwards ($t(56)=-7.59, p<.0001, \beta=-.92$) (Table 1). This confirmed that a substantial change in print media reports occurred in month-9 for HPV4 but not MNQ.

Spike in print media drives VAERS reporting for HPV4

We next posited that this print media spike in month 9 would act as a catalyst to increase monthly VAERS reports for HPV4 but not for MNQ. The “catalytic event” was coded as a dichotomous variable (months 1–8 vs. months 9–31), and a new interaction term was created from the product of vaccine type and the catalytic event. The model was significant ($F(5, 56)=68.62, p<.0001, R^2=.86$) and the interaction term added significantly to the fit of the model ($F(1, 56)=62.58, p<.0001, \Delta R^2=.19$). In months 1–8, the number of VAERS reports/month was not significantly different between HPV4 and MNQ. However, in months 9–31, HPV4 was associated with more VAERS reports than MNQ ($t(56)=7.91, p<.0001, \beta=.45$) (Table 1). This significant interaction supports our hypothesis that the spike in print media in month 9 may have been the catalyst needed to increase HPV4-associated VAERS reporting over the following months (Figure 2).

Internet search activity varied across time and by vaccine type

While this catalytic event was associated with an increase in the number of VAERS reports, it did not necessarily explain why the number of VAERS reports increased even in the post-spike period when the number of print media reports decreased to levels matching MNQ (see the bottom of Figure 1, After Spike). We posited that the relationship between the catalytic event and increase in VAERS reports was actually mediated by a third variable—Internet search activity. Before testing this hypothesis, we examined the correlation between print media reports and Internet search activity, and evaluated whether there was a significant rise in Internet search activity in month-9 for HPV4 but not MNQ. HPV4 generated significantly more average activity ($M = 62.29, SD = 18.38$) than MNQ ($M = 7.35, SD = 3.29$), $t(60) = 16.38, p < .0001$. In a similar fashion as print media reports, Internet search activity increased in months 9–31 for HPV4 ($\beta=.23$), but remained stable for MNQ ($F(56)=22.67, p<.0001$) (top of Figure 1).

Internet search activity as a mediator between print media and VAERS reporting

Considering the similar pattern, we examined the effect of Internet search activity on VAERS reporting and whether Internet search activity was a mediating step between the catalytic event and the increase in VAERS reports (Figure 3). We included an interaction term of Internet search activity by vaccine type to evaluate whether it accounted for some or all of the variance explained by the interaction of the catalytic event and vaccine type. Running a moderated regression model controlling for continuous time, monthly print media reports, and including these two interaction terms, our model was statistically significant ($F(8,53)=72.95, p<.0001, R^2=.91$). Not only was the new interaction term of Internet search

activity by vaccine type significant, ($t(53)=1.98$, $\beta=.24$; $F(1, 53)=3.99$, $p=.05$, $\Delta R^2=.01$), but it pushed the catalytic event by vaccine type interaction out of statistical significance (from $p<.0001$ to $p=.21$). Moreover, the Sobel-test concluded that the catalytic event indeed predicted the increase in Internet search activity, which then predicted the increase in VAERS reporting for HPV4 ($\beta=.61$, $p<.0001$) (Sobel statistic=2.64, *two-tailed* $p=.008$). To ensure this was a unique phenomenon, we tested the same mediation pattern (i.e., catalytic event $\rightarrow$ Internet search activity $\rightarrow$ VAERS reporting) on MNQ, but it did not reach statistical significance (Sobel statistic=1.31, *two-tailed* $p=.19$).

Discussion

As hypothesized, there was a temporal association between the frequency of media reports and the frequency of VAERS reports for HPV4, while none was found for MNQ. During the initial 2.5-years post-FDA licensure, the frequency of media reports related to MNQ remained stable and low. In contrast, for the HPV4 vaccine, there was an intense spike in media coverage during month-9 post-FDA licensure, followed by a period of decline, in which the frequency of HPV4-related media reports remained similar to MNQ. Starting just before month-9 and continuing forward, there was an increase in the number of HPV4-associated adverse event reports to VAERS. This increase coincided initially with the increase in print media coverage and subsequently, Internet search activity. Moreover, our research indicates that adverse events reports remained high despite waning print media coverage as the interest continued to flourish on the Internet.

The HPV vaccine received a great deal of mainstream media attention in the months following its licensure. However, it does not appear that this attention focused solely on the potential side effects of vaccination. Previous content analyses have indicated that while the news media may have provided some information about the efficacy of the vaccine and the link between HPV and cervical cancer (17,18), many reports excluded important information such as the need for continued cervical cancer screening after vaccination, the mode of transmission for HPV (19), potential side effects, and the cost of vaccination (18). Notably, Johnson and colleagues (18) found that mentions of the sexual nature of transmission and the link between HPV and cervical cancer were more frequent in news reports after February 2007 when Gov. Rick Perry enacted his mandate. Therefore, although the news reports could have been more informative, they did not seem to be emphasize the risk of adverse events. Although we did not assess the content of the print media reports in this study, previous literature does not seem to indicate that reports were unbalanced or overwhelmingly positive or negative. This gives us further evidence to believe that the sheer volume of interest in HPV vaccination by the media in the months following FDA approval (particularly in February 2007), rather than the content of the messages themselves, was related to VAERS reporting patterns.

News media activity can set the agenda for public discussion regarding a topic, and today much of that discussion takes place on the Internet. In essence, the Internet acts as a cheap, accessible forum for users to relay and debate information from print media sources. Although the majority of HPV vaccine-related news articles on the Internet have also been found to be neutral (20), anti-vaccination activists and parents who are worried about the potential side effects of vaccination can find outlets for their messages through web-based applications that allow users to share comments or content with others (e.g., Facebook, Twitter, Wikipedia, Youtube, and LinkedIn) (21–25). These applications, collectively known as Web 2.0, aid in the continuity of discussion amongst peers with varying degrees of (accurate and inaccurate) information on vaccination and may ultimately influence vaccination decisions. Additionally, there are a host of “anti-vaccination” websites that include claims of vaccines causing illness or adverse events (26–28). Such claims are often

drawn from VAERS data (28), despite the organization's disclaimer that one cannot infer causal relationships from the data without further investigation. According to Wolfe et al. (28), 95% of anti-vaccination websites also claimed that adverse events were underreported due to physicians' delay or failure to report them. This type of information may spur audiences to report to VAERS any adverse events/illness proximal to vaccination, whether or not it has any possible vaccine connection (30, 31).

It is important to note that our results do not necessarily suggest that media coverage spurs people to report inaccurate or false adverse events, but rather that media coverage may increase awareness of the VAERS program, the potential to experience side effects, and/or the importance of reporting possible side effects. Media consumers may be more likely to notice side effects because they are told to look for them and advised to report concerns. It should be noted however that the rise in adverse event reporting was only observed for HPV4, not MNQ, suggesting that the increase in reporting was likely due to the spike in HPV4-related media coverage rather than increasing vaccine uptake over time. Moreover, this observed "Weber effect" seems reflective of increased publicity rather than patient exposure, dosage forms, or changes to the manufacturing process. Finally, we cannot rule out that the difference in frequency of VAERS reports between MNQ and HPV4 were not a real consequence of differing rates of side effects experienced by those vaccinated. However, based on their respective package inserts, HPV4 and MNQ both report low rates of serious adverse events (0.8 vs. 1.0%, respectively). Differences were noted for several mild side effects such as malaise (HPV4=1.4%, MNQ=21.9%), injection site pain (HPV4=83.9%, MNQ=59.2%), swelling (HPV4=25.4%, MNQ=10.8%) and joint pain (HPV4=1.2%, MNQ=17.4%), however they were not always elevated in the same vaccine (32, 33). Moreover, although we cannot prove the rates of actual side effects differed between vaccines, we do not believe the higher rates reported for HPV4 are associated with the fact that HPV4 requires more doses (3 vs. 1). During the time our data was collected, HPV4 was only recommended for females and many women had not yet completed the 3 dose series, whereas MNQ was recommended for both males and females and had a slightly higher uptake rate (34). Our study demonstrated a correlation between the number of HPV-related print media reports, Internet search activity, and VAERS reporting. Although we did not adjust for the content of the news reports and/or Internet search activity, previous studies have shown a mix of positive and negative messages regarding vaccination in both data sources. While it may be that any increase in print media or Internet search activity, regardless of the content of its messages, will increase VAERS reporting, it may also be the case that VAERS reporting is related to how the issue was framed in the media/Internet. Moreover, future research should focus on how the frequency of negatively-framed messages impacts VAERS reporting. Additionally, our findings suggest the need for public health education efforts on the Internet regarding potential vaccine side effects and appropriate use of the VAERS system, where the discourse may be muddled by anti-vaccination messages and general misinformation provided by the public.

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Appendix

Top-circulating newspapers* used to extract print media reports

Newspaper Circulation Rank	Rank by Population Size (Top 10 Only)	Newspaper Name	Largest reported circulation as of 3/31/06
1		<i>USA Today</i> (Arlington, Va.)	2,528,437
3	1	<i>Times</i> (New York, N.Y.)	1,683,855
4	2	<i>Times</i> (Los Angeles)	1,231,318
5		<i>Post</i> (Washington, DC)	960,684
7	1	<i>Daily News</i> (New York, N.Y.)	795,153
8	5	<i>Inquirer</i> (Philadelphia)	705,965
10	4	<i>Chronicle</i> (Houston)	692,557
11	1	<i>Post</i> (New York, N.Y.)	691,420
12		<i>News/Free Press</i> (Detroit)	669,315
13	9	<i>Morning News</i> (Dallas)	649,709
14		<i>Star Tribune</i> (Minneapolis)	606,698
16		<i>Star-Ledger</i> (Newark, N.J.)	599,628
17		<i>Journal-Constitution</i> (Atlanta)	561,405

Newspaper Circulation Rank	Rank by Population Size (Top 10 Only)	Newspaper Name	<i>Largest reported circulation as of 3/31/06</i>
19	1	<i>Newsday</i> (Long Island, N.Y.)	488,825
20		<i>Chronicle</i> (San Francisco)	451,504
35	7	<i>Express-News</i> (San Antonio, Tex.)	342,709

* The Wall Street Journal, Chicago Tribune, Post/Rocky Mountain News, Boston Globe, San Diego Union-Tribune, and Arizona Republic were not index in LexisNexis and could not be queried, despite being in the top 20 circulating newspapers or top 10 in population size.

Implications and Contribution

The abundance of media coverage and public interest in HPV vaccination in the months following the FDA's approval of Gardasil® was strongly related to the increase in HPV vaccine-associated adverse events reported to VAERS.

Figure 1.

Temporal pattern in print media and Internet activity by vaccine type. These panels represent the “volume” of print media reports and Internet search activity relating to HPV4 (dotted line) and MNQ (solid line) in the first 2.5 years post-FDA approval of each respective vaccine. Volume of print media reports was measured as the total number of unique news reports in top circulating U.S. newspapers per month and volume of Internet search activity was measured as the popularity of the search terms “Gardasil” vs. “Menactra” in Google Search per month, normalized and scaled from 0–100. Moderated regression models indicated a significant spike in print media reports in month-9 post-FDA approval for HPV4 but not MNQ, and a significant increase in Internet search activity for HPV4 in months 9–31 for HPV4 but not MNQ.

Figure 2.

Temporal pattern in VAERS reporting by vaccine type. This figure represents the total number of VAERS reports per month for HPV4 (dotted line) vs. MNQ (solid line). A moderated regression model found no significant differences in the number of VAERS reports/month between MNQ and HPV4 in months 1–8 post-FDA approval of each respective vaccine. In months 9–31, however, HPV4 was associated with more VAERS reports than MNQ, suggesting that the spike in print media in month-9, post-FDA approval, acted as a transitional event to increase HPV4-associated VAERS reporting.

Figure 3.

Internet search activity as a key mediating step towards increased VAERS reports for HPV4 model. The MNQ vaccine remained an included comparison group throughout. Whole lines reflect main effects and are independent of moderation by vaccine type, except when involving the vaccine variable itself (e.g., vaccine directly predicting internet search activity). Dotted-lines reflect relationships unique to the HPV4 vaccine.

Notes: ** P-value <0.01 * P-value <0.05

Table 1

Moderated Regression Tables

Model 1: Print Media Reports By the Interaction of Vaccine Type and Spike-Level (Months 1-8, 10-31, Vs. Month-9)						
Variable	Estimate	Std Error	Std Beta	t Ratio	Prob> t	
Intercept	42.79	4.05	0	10.57	<.0001*	
Time ^c	-0.77	0.26	-0.34	9.13	<.0001*	
Vaccine [HPV4]	24.97	2.73	1.21	3.01	0.004*	
The Spike [Months 1-8]	26.45	3.59	0.64	7.37	<.0001*	
The Spike [Month 10-31] ^a	-16.09	3.71	-0.42	-4.33	<.0001*	
Vaccine [HPV4] x The Spike [Months 1-8]	21.71	3.12	0.58	6.96	<.0001*	
Vaccine [HPV4] x The Spike [Months 10-31] ^a	-21.94	2.89	-0.92	-7.59	<.0001*	
Model 2: VAERS Reports By the Interaction of Vaccine Type and Before Vs. After the Spike						
Variable	Estimate	Std Error	Std Beta	t Ratio	Prob> t	
Intercept	67.12	13.45	0	4.99	<.0001*	
Time ^c	1.42	0.87	0.14	1.64	0.11	
Vaccine [HPV4]	44.62	5.44	0.48	8.20	<.0001*	
Print News Media ^c	-0.62	0.26	-0.14	-2.44	0.02*	
Before vs. After the Spike [Before the Spike]	40.28	8.60	0.38	4.68	<.0001*	
Vaccine [HPV4] x Before vs. After the Spike [Before the Spike]	42.04	5.31	0.45	7.91	<.0001*	
Model 3: VAERS Reports By the Interaction of Vaccine Type and Before Vs. After the Spike						
Variable	Estimate	Std Error	Std Beta	t Ratio	Prob> t	
Intercept	-7.22	16.37	0	-0.44	0.66	
Time ^c	1.52	0.71	0.15	2.14	0.04*	
Vaccine [HPV4]	50.99	23.55	0.55	2.17	0.03*	
Print News Media ^c	-1.18	0.23	-0.26	-5.19	<.0001*	
Before vs. After the Spike [Before the Spike]	31.46	7.50	0.30	4.19	0.0001*	

Model 1: Print Media Reports By the Interaction of Vaccine Type and Spike-Level (Months 1-8, 10-31, Vs. Month-9)

Variable	Estimate	Std Error	Std Beta	t Ratio	Prob> t
Internet Activity	3.71	0.87	1.21	4.25	<.0001*
Internet Activity * Before vs. After the Spike [Before the Spike] ^c	0.55	0.42	0.18	1.29	0.20
Vaccine [HPV4] * Before vs. After the Spike [Before the Spike]	13.66	10.72	0.15	1.27	0.21
Vaccine [HPV4] * Internet Activity	1.72	0.87	0.24	1.98	0.05*

Notes.

The "Time" variable represents the monthly count (i.e., Month-1, Month-2, Month-3...Month-29, Month-30, Month-31). Referent categories are in brackets.

* Denotes statistical significance.

^a These estimates were negative because these nominal levels were compared against the Month-9 nominal level which was greater (i.e., Month-9 was the referent).

^c Denotes control variables and terms.