

SHORT REPORT



“To each his own”: Discussions of vaccine decision-making in top parenting blogs

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ABSTRACT

Although social media provides a way for people to congregate with like-minded others, it can also play a role in spreading misinformation about public health interventions. Previous research demonstrates that parents who use the Internet to gather information on vaccination are more likely to hold anti-vaccination beliefs. There has been little examination of vaccination decision-making discussions on parenting blogs. This study seeks to fill that gap. Posts and comments on the top 25 parenting blogs were analyzed using a mixed-method approach. Comments were analyzed using deductive coding scheme that examined whether content areas of interest were present or absent in vaccination discussions. Posts were coded inductively using a thematic analysis. Posts and comments were further coded as strongly vaccine-discouraging, vaccine-ambivalent, or strongly vaccine-encouraging. Finally, posts were grouped by year of publication and comments were analyzed within each group to examine the evolution of vaccination decision-making discussions in the parenting blogosphere over the past decade. Fifty-two percent of posts were categorized as strongly vaccine-discouraging and were most commonly associated with expressions of individual liberty. Comments were nearly 3 times as likely to strongly discourage vaccination than to strongly encourage it. Comments on the oldest posts (2006–2009), were more likely to strongly discourage vaccination ($p = 0.008$), whereas comments on newer posts (2013–2015), were more likely to strongly encourage vaccination ($p = 0.003$). These findings suggest there is a need for public health professionals to understand the concerns being expressed in these forums, and develop innovative ways to dispel anti-vaccination myths, as these views may create obstacles in the meeting the goals of the public health agenda.

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Introduction

Historically speaking, some of the greatest achievements in public health are associated with successful vaccine development.¹ As such, eradication of smallpox has been achieved, and we are nearing eradication of other infectious diseases.² Vaccines are a cost-effective method of preventing childhood diseases.³ However, like other medical interventions, vaccines are not devoid of risk. Repercussions from vaccinations range from allergic reactions to life threatening complications.⁴ Surveillance programs have been established to monitor adverse reactions to vaccines⁵ and although reactions to vaccines are not common, when they do occur, they often gain public attention and heighten concern among the public, and of parents in particular. Over the past several decades, fear has shifted from contracting infectious diseases to vaccine reactions in industrialized countries.^{6,7}

Parents play an integral role in maintaining the immunization schedule of their children. Concerns regarding the number of vaccinations and the potential to inundate the child's immune system may lead parents to believe that a non-standard schedule is safer because the vaccines will be spread out over a longer

period of time.⁸ In concert, parents may be concerned about the composition of the vaccines including antigens, adjuvants, aluminum, or Thimerosal.⁸ Parents may additionally fear that the composition of the vaccines are the causative agent for conditions⁸ ranging from autism to idiopathic illness.^{9,10} Based on such concerns, parents may try to determine if their child's risk of exposure to specific diseases outweighs the risk believed to be associated with vaccination.⁸ In understanding how parents negotiate fears, weigh risks and benefits, and ultimately make choices around vaccination, sources of information become an important factor to consider.

In the digital era, the Internet impacts parents' vaccination choices for their children.¹¹ Individuals who use the Internet are more likely to hold beliefs about vaccinations that are not supported by scientific research.¹¹ Internet users are also more likely to believe that healthy children do not need to be vaccinated and vaccines do more harm than good.¹¹ A study conducted by Davies et al. (2002) involved searching “vaccination” in 7 search engines with 43% of the hits yielding an anti-vaccination site.¹² Moreover, 100% of the first 10 hits on Google were anti-vaccination.¹² Notably, Google searches for information about possible

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vaccine-related side-effects have increased over time.¹³ In Brunson's (2013) survey of 196 parents' vaccination views and practices, 70 parents stated they did not follow the recommended vaccination schedule.¹⁴ Furthermore, these 70 parents had a high percentage (72%) of individuals in their social networks who advised not conforming to the recommended vaccination schedule.¹⁴ Only 13% of members on conformers' social networks recommended not conforming.¹⁴

Online media platforms such as blogs, YouTube, Twitter, and Facebook transcend across geographical boundaries allowing people to communicate with individuals they once never had access to.¹⁵ Although social media provides a way for people with like-minded beliefs to congregate leading to them feeling empowered, it can also play a role in spreading misinformation.¹⁵ Social media can serve as a platform for individuals to undermine medical advances, such as the value of vaccines.¹⁵ Wilson & Keelan (2013) found that people with anti-vaccination attitudes using social media prefer to connect with those who take similar stances and are not interested in hearing views that counter their own.¹⁵ In fact, hearing alternate viewpoints lead to greater intensification of opposition.¹⁵

Given the ability of Internet users to disseminate information and opinions to wide audiences, it is important that health-care professionals understand the current online content related to vaccinations. Centers for Disease Control and Prevention (CDC) uses a variety of social media sites, including Facebook, LinkedIn, and Twitter, to provide information seekers with scientifically based health information.¹⁶ The CDC attempts to be where the conversation is happening in attempt to prevent the spread of misinformation.¹⁶ The use of blogs is a popular method for engaging in conversations and disseminating information on vaccines. They thus need to be monitored to understand current sentiments regarding vaccination and respond to criticism.¹⁷ Nevertheless, to date, there is a paucity of research analyzing the content of parenting blogs for vaccination content. In particular, given the option on many blogs for readers to leave comments, it is necessary to analyze the conversations that follow. The purpose of this study is thus to fill that gap by describing content related to vaccination on the most popular parenting blogs. We sought to understand, using both quantitative and qualitative methods, first, what evidence and attitudes are used on blog posts and the corresponding discussions that ensue in the comments sections, and second, whether or not discussions of vaccination on parenting blogs had changed over the past decade.

Methods

To analyze discussions of vaccination decision-making among parents, the 25 most popular parenting blogs were identified using the Blogmetrics website, which rates blogs by content area and popularity. Specifically, blogs were chosen using Blogmetrics' "Ultimate Ranking" system, which classifies blogs according to cumulative results of 6 different individual ranking systems: Feedburner RSS membership; unique monthly visitors; Google indexed pages; the number of incoming links via Bing; Google PR, and Alexa rank. The blogs included in this study were ranked most popular as of 7/19/2016.

To be included in the data set, blogs needed to meet the following criteria: have searchable content; allow comments, and have articles on vaccines or vaccination for humans. Inclusion criteria for articles consisted of the following: articles must have been published within the last 10 years; articles must include discussion of vaccines/vaccination for humans; articles must have comments; comments must have discussed vaccines/vaccination for humans. If the article only mentioned but didn't discuss vaccines/vaccination and it wasn't discussed in the comments, it was rejected. Based on these criteria, 14 blogs, 46 blog articles, and 697 comments were included in the final data set (Table 1).

Articles and comments were analyzed using a mixed-method approach. Article comments were first analyzed with a deductive coding scheme that examined whether or not the following were present or absent in discussions of vaccinating children: evidence from medical/animal studies to support views; autism causality; signs/symptoms of adverse reaction to vaccination; Thimerosal or Mercury in vaccines; SIDS/Guillain Barre Syndrome/Medical condition other than autism as related to vaccination; overloading the immune system with too many vaccines at once; deviating from recommended vaccination schedule; risk of adverse reaction is less than risk of illness; herd immunity; dosage for infants vs. adults; VAERS or vaccine count; mandates for school entry; risks not fully understood or disclosed; condescending attitudes of doctors when refusing vaccines; trusting doctors' opinions and recommendations toward vaccines; motivations of pharmaceutical industry; distrust of government; entanglement of government and industry, and natural remedies to boost immunity. Blogs and comments were further categorized as strongly vaccine-encouraging, vaccine-ambivalent, or strongly vaccine-discouraging as well as strongly encouraging, ambivalent about, or strongly discouraging the use of natural remedies to boost immunity. This coding scheme was adapted from one used in a previous study by Basch et al. (2017),¹⁸ which examined discussions of vaccination in YouTube videos. Due to limited frequency counts, blog content was not conducted quantitatively, but rather the 46 blog articles were coded inductively using a thematic analysis. Finally, to examine the evolution of vaccination decision-making discussions in the parenting blogosphere over the past decade, blog articles were grouped by year of publication and comments were analyzed within each group. Natural breaks were used to create 3 groups of approximately equal numbers of posts within each group: 2006–2009, 2010–2012, and 2013–2015.

This paper is primarily descriptive in nature. SPSS (version 23) was used to calculate frequencies and perform statistical tests. Chi-square tests of association were used to compare blog posts based on time period. When one or more cells had an expected frequency of 5 or less, Fisher's exact tests were used instead. The additional inductive thematic coding analysis was conducted using cloud-based internet software Dedoose.¹⁹ One hundred and 10 inductive codes were examined for co-occurrence with the categorization of blog articles as vaccine-encouraging, vaccine-ambivalent, or vaccine-discouraging.

The institutional review board at William Paterson University does not review studies that do not involve human subjects research.

Table 1. Description of blog posts.

Rank*	Blog	Blog Post	Year Published	Vaccine Stance
1	Nature Moms Blog	Thimerosal banned from kids' vaccines	2006	<i>Discouraging</i>
		Gardasil Vaccine Hoax	2007	<i>Discouraging</i>
		New Jersey Poised to Make Vaccines Required by Law!	2007	<i>Discouraging</i>
		The Vaccine Issue - My Son's Story	2007	<i>Discouraging</i>
		He's not Autistic, but...	2008	<i>Discouraging</i>
		Vaccines, Toys, and Homeschool Stuff	2008	<i>Discouraging</i>
		Anger Toward the Anti-Vaccine & Informed Consent Movements	2009	<i>Discouraging</i>
		Speech, Vaccines, and Earth Day	2009	<i>Discouraging</i>
		Happy Birthday Paige!	2009	<i>Discouraging</i>
		Motherhood Regret and Mistakes	2009	<i>Discouraging</i>
		Wrap-up - Butterflies for the Holocaust	2009	<i>Discouraging</i>
		Stay Well - Stay Away from the White Stuff	2009	<i>Discouraging</i>
		Forced Vaccinations Bill Passes MA Senate!	2009	<i>Discouraging</i>
		It's a Wrap - Cool Links and Blogs	2009	<i>Discouraging</i>
		When Doctors Try to Blackmail Parents	2010	<i>Discouraging</i>
		The Non Toxic Avenger - Book Review	2011	<i>Discouraging</i>
		When Natural Parenting Makes You the Odd One Out	2011	<i>Discouraging</i>
		Attachment Parenting During Pregnancy	2011	<i>Discouraging</i>
		15 Ways to Boost Vaccination and Keep Illness Away Without Vaccines	2012	<i>Discouraging</i>
		2	2 Wired 2 Tired	Challenges Conventional Nutrition and Health Ideas
Holistic Solutions for Back to School Illness	2013			<i>Discouraging</i>
3	A Happy Hippy Mom	Detroit Child Vaccinated at School Without Parental Consent	2013	<i>Discouraging</i>
		How You Can Help Kmart Support the March of Dimes & A Giveaway	**	<i>Encouraging</i>
4	The Shopping Mama	Pro-Vax - Anti-Vax? Enough is Enough?	**	<i>Encouraging</i>
		Is your little one getting Vitamin D?	2010	<i>Encouraging</i>
5	Southern Bella's Ways	Autism-Vaccine Link Debunked (Again)	2011	<i>Encouraging</i>
		Flu Season is Here! Tips & Tricks to Stay Healthy	2013	<i>Ambivalent</i>
6	Mom Fuse	I'll be at the 2013 Shot@Life Champion Summit in Washington DC #globalvax	2013	<i>Encouraging</i>
		Why Your Choice Not to Vaccinate Puts Everyone at Risk	2015	<i>Encouraging</i>
7	From Dates to Diapers, and Beyond!	Am I A "Parasite"?	**	<i>Ambivalent</i>
		Two Chicken Pox Vaccinations... So Why Am I Home with a Child who has Chicken Pox?	2010	<i>Ambivalent</i>
8	MomDot	Friendly Government Intervention	2013	<i>Ambivalent</i>
		Protect Yourself and Your Family with a Flu Vaccination #NIVW2014	2014	<i>Encouraging</i>
9	Baby Loving Mama/Finding Zest	Be Prepared: Flu Shots Available at CVS MinuteClinic #FluPlusYou	2014	<i>Encouraging</i>
		"One Pack = One Vaccine" - How You Can Help	2008	<i>Encouraging</i>
10	An Island Life	You Can't Force Me To Stick a Needle In My Child	2011	<i>Ambivalent</i>
		We've Got the Pox (and the Rest of Your Email Questions)	2012	<i>Encouraging</i>
11	Green Mama's Pad	Pennsylvania preschooler bit by a bat in the classroom	2011	<i>Ambivalent</i>
		Measles cases in US at highest rate in 15 years	2011	<i>Encouraging</i>
12	Wanting What You Have	AAP corrects Michele Bachmann on HPV vaccine safety	2011	<i>Encouraging</i>
		Study: No increase of febrile seizures in kids ages 4 to 6 after MMRV vaccine	2012	<i>Encouraging</i>
13	Imperfect Parent	Sarah Michelle Gellar advocates for pertussis vaccine	2013	<i>Encouraging</i>
		Is whooping cough rise result of anti-vaccination movement?	2013	<i>Encouraging</i>
14	My Thoughts, Ideas and Ramblings	Pennsylvania Toddler Dies of Common Ear Infection	2015	<i>Encouraging</i>
		I'm Saving Babies Lives and so can you	2008	<i>Encouraging</i>
		Back to School with Walgreens #Giveashot #shop #CBIAS	2014	<i>Encouraging</i>

*Rank based on inclusion criteria.

**Date not published.

Results

Blog posts

Using the qualitative data analysis software program Dedoose¹⁹ 110 inductive codes were examined for co-occurrence with the designation of a blog post as strongly vaccine-discouraging (24

out of 46 articles), vaccine-ambivalent (6 out of 46 articles), or strongly vaccine-encouraging (18 out of 46 articles). Based on this analysis, blogs coded as strongly vaccine-discouraging were commonly associated with the belief that parents who refuse vaccination have made informed decisions, a suspicion of biomedical interventions, the belief that vaccines as being filled

with dangerous chemicals and toxins, and fear that vaccination causes harm to children. As the most prolific poster on vaccination within the data set (and, notably, the top parenting site according to Blogmetrics' Ultimate Ranking system by far), Green Mama's Blog best exemplifies these viewpoints. For instance, in a 2007 post, a Green Mama blogger states that she blogs on vaccination not to convince others, but to tell "both sides" of the story because it is a parent's right to know the "whole truth" (9/25/2007). Bloggers whose posts were characterized as strongly vaccine-discouraging tended to frame the issue of vaccination as one of individual liberty and a private family matter. As an illustration, a Green Mama blogger argues in a 2008 post that she had her husband concluded after years of research that the probability of their children being harmed by vaccines was greater than the probability that vaccines would protect their children from infectious disease. She acknowledged that other parents may make different decisions and concluded, "to each his own" (7/25/2008). Similarly, in a 2011 post, a Green Mama's Pad blogger asserts, "I might not agree with your choices, but that is none of my business. They are your choices to make, not mine. I expect the same in return" (11/14/2011). And a From Dates to Diapers, and Beyond! blogger writes that although she and her husband made their decision not to vaccinate their children after engaging in lengthy research and prayer, she does not criticize others parents for making different decisions. Notably, in other posts these same bloggers harshly criticized state vaccination requirements for public education.

Blog posts that were classified as vaccine-ambivalent were most commonly associated with concerns that vaccines are not 100% effective and the belief in an alternative schedule. In the following quote, the author of the blog Southern Bella's Ways to Save can be seen to struggle with the efficacy of vaccination: "I went back and forth about vaccinations this year. We were planning on it, but then a friend of ours got her family vaccinated and her son got the flu. I know it's a SMALL percentage that actually get the flu from the vaccine and I'm pro vaccine in other areas, but after talking with my husband we decided to not get it this year" (11/26/2013, emphasis in the original). Similarly, in referring to the 2014–2015 Disneyland measles outbreak, a Happy Hippy Mom blogger argues that vaccination didn't protect children in the amusement park from contracting the disease (no published date). She states that although she supports vaccination, she believes more research should be done on the immunization schedule and bundled shot effectiveness. Bloggers on Dates to Diapers, and Beyond! (July 2008), Mom Dot (December 2013), and Green Mama's Pad (11/14/2011) all follow alternative vaccination schedules in an attempt to avoid what they believe to be an overloading of children's immune systems. As a Mom Dot blogger puts it, "I simply don't believe a 5 month old needs a 5 injections at once. This is simply a personal opinion from a parent that has 2 very healthy awesome kids that are no worse for the wear over delaying" (December 2013). In concert with strongly vaccine-discouraging bloggers, in the vaccine-ambivalent posts, alternative schedules were often described as a matter of personal choice.

A belief in the efficacy of vaccination, the assertion that vaccination and vaccination schedules were based on sound scientific evidence, and the moral duty to help stop the spread of disease (including by protecting the immunocompromised)

were most frequently seen in posts characterized as strongly-vaccine encouraging. In their discussions of vaccination, bloggers on The Shopping Mama (1/6/2011) and Imperfect Parent (5/25/2011) both take aim at anti-vaccination beliefs by discussing the Andrew Wakefield scandal, noting that Wakefield's assertion that the MMR vaccine causes Autism has been thoroughly disproven. Authors at Finding Zest (12/9/2014) and Imperfect Parent (9/13/2011) cite agencies and organizations such as the American Academy of Pediatrics, the Centers for Disease Control and Prevention, and the American Academy of Family Physicians in arguing for the efficacy and importance of vaccination. And as with many of the strongly-vaccine encouraging posts, a Mom Fuse (2/19/15) blogger frames vaccination as a duty of citizenship. In the following post, she can be seen as challenging the notion that personal choice outweighs collective responsibility: "It's important in America that we all have a right to make choices, but what happens when those choices put others at risk?"

Blog comments

The number of comments on individual blog posts ranged from 1 to 77 with an average of 29. Comments were nearly 3 times as likely to strongly discourage vaccination (18.9%) than to strongly encourage it (7%) (Table 2). Thirty-three comments (4.7%) mentioned delaying vaccination from the recommended scheduling. Similarly to the bloggers, the use of scientific evidence by readers either in favor of or against vaccination was uncommon, occurring in only 50 comments (7.2%). Seventy-four comments (10.6%) mentioned the signs or symptoms of adverse reactions. These included Sudden Infant Death Syndrome, Guillain-Barre Syndrome or another medical condition (6.6%) and autism (5.4%). Discussions of Thimerosal or mercury (1.4%), overloading the immune system (1.7%), the risk of illness being less than the risk of adverse reactions (1.4%), or the risks of vaccines not being fully understood or disclosed (1%) were rare. Forty-five comments (6.4%) mentioned natural remedies to boost immunity in place of vaccination. Slightly fewer comments (2.6%) mentioned trusting doctors' opinions and recommendations toward vaccines than mentioned the condescending attitudes of doctors when refusing vaccines (3.7%). Roughly 2 dozen comments mentioned political immunization mandates for school entry (3.2%), profit motivations of the pharmaceutical industry (3.2%), distrust of the government (3.3%), or the entanglement of the government and the pharmaceutical industry (4.2%).

The blogs with the highest percentage of comments strongly encouraging vaccines were A Happy Hippy Mom (100%), An Island Life (60.0%), and Finding Zest (33.3%). The highest percentages of comments strongly discouraging vaccines were found on From Dates to Diapers, and Beyond! (42.9%) and Nature Mom's Blog (24.6%). While the overall use of scientific evidence was uncommon, Imperfect Parent was an outlier with 64% of comments using evidence. Of the 26 comments that mentioned the condescending attitudes of doctors when refusing vaccines, 24 were on Nature Mom's Blog, compromising 5.5% of comments on the blog. Natural remedies were most frequently mentioned on The Shopping Mama (23.1%) and Southern Bella's Way to Save (28.6%). Due to the heterogeneity

Table 2. Analysis of blog comments.

Blog:	Total	1	2	3	4	5	7	8	9	10	11	12	13	14	15
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Total comments	698	435	6	1	13	14	2	7	59	12	5	35	5	78	25
Uses evidence	50 (7)	28 (6)	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	3 (9)	0 (0)	0 (0)	16 (64)
Strongly encourages vaccination	49 (7)	14 (3)	0 (0)	0 (0)	4 (31)	3 (21)	0 (0)	1 (14)	10 (17)	4 (33)	3 (60)	5 (14)	0 (0)	4 (5)	0 (0)
Strongly discourages vaccination	132 (19)	107 (25)	0 (0)	0 (0)	1 (7)	1 (7)	0 (0)	3 (43)	9 (15)	0 (0)	0 (0)	4 (11)	0 (0)	0 (0)	7 (28)
Mentions...															
Natural remedies to boost immunity	45 (6)	36 (8)	0 (0)	0 (0)	3 (23)	4 (29)	0 (0)	0 (0)	0 (0)	1 (8)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0.0)
Signs and symptoms of adverse reaction	74 (11)	47 (11)	0 (0)	0 (0)	1 (7)	1 (7)	0 (0)	2 (29)	6 (10)	0 (0)	0 (0)	6 (17)	1 (20)	1 (1)	9 (36)
Autism	38 (5)	27 (6)	0 (0)	0 (0)	2 (15)	0 (0)	0 (0)	1 (14)	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	6 (24)
Thimerosal or mercury in vaccines	10 (1)	10 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Sudden Infant Death Syndrome, Guillain-Barre Syndrome, or other medical condition	46 (7)	24 (6)	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	7 (12)	0 (0)	0 (0)	4 (11.4)	0 (0)	1 (1)	9 (36)
Overloading immune system with too many vaccines at once	12 (2)	4 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (9)	0 (0)	0 (0)	2 (6)	1 (20)	0 (0)	0 (0)
Herd immunity	4 (0.6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (29)	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Risk of illness being less than risk of adverse reaction	10 (1)	7 (2)	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (8)
Risks not being fully disclosed or understood	7 (1)	7 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Delaying vaccination from recommended scheduling	33 (5)	15 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	12 (20)	0 (0)	0 (0)	6 (17)	0 (0)	0 (0)	0 (0)
Political immunization mandates for school entry	22 (3)	13 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	1 (2)	0 (0)	0 (0)	7 (20)	0 (0)	0 (0)	0 (0)
Condescending attitudes of doctors when refusing vaccines	26 (4)	24 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)
Trusting doctors' opinions and recommendations toward vaccines	18 (3)	12 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (14)	1 (2)	0 (0)	0 (0)	1 (3)	0 (0)	0 (0)	3 (12)
Profit motivations of pharmaceutical industry	22 (3)	15 (3)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	1 (14)	1 (2)	0 (0)	0 (0)	1 (3)	0 (0)	0 (0)	3 (12)
Distrust of government	23 (3)	16 (4)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	0 (0)	4 (7)	0 (0)	0 (0)	1 (3)	0 (0)	0 (0)	1 (4)
Entanglement of government and pharmaceutical industry	29 (4)	16 (3)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50)	0 (0)	4 (7)	0 (0)	1 (20)	6 (17)	0 (0)	0 (0)	1 (4)

Key: 1: Nature Mom's Blog; 2: 2 Wired 2 Tired; 3: A Happy Hippy Mom; 4: The Shopping Mama; 5: Southern Bella's Ways to Save; 6: Mom Fuse; 7: From Dates to Diapers, and Beyond!; 8: MomDot; 9: Finding Zest; 10: An Island Life; 11: Green Mama's Pad; 12: Wanting What You Have; 13: Imperfect Parent; 14: My Thoughts, Ideas, and Ramblings.

of the blogs in terms of number of posts and number of comments, we chose not to perform statistical tests on the 14 blogs but rather to group them by publication date.

Table 3 presents the descriptive statistics for the blog posts by date of publication. In examining the evolution of comments on vaccination over the past decade, comments on the oldest posts, published from 2006–2009, were more likely to strongly discourage vaccination ($p = 0.008$), whereas comments on newer posts, published from 2013–2015, were more likely to strongly encourage vaccination ($p = 0.003$). Comments on older posts were more likely to mention Thimerosal or mercury in vaccines ($p = 0.010$), risks of vaccines not being fully disclosed or understood ($p = 0.042$), and the condescending attitudes of doctors when refusing vaccines ($p = 0.037$).

Discussion

The findings of this study demonstrate that many blog posts and subsequent comments take an anti-vaccination standpoint. This is consistent with findings from other studies, which indicate that there is an anti-vaccination sentiment apparent when searching on the Internet.^{9,20} A study by Nan and Madden (2012) found that those who read anti-vaccination blogs related to HPV were not only more likely to view the HPV vaccination as being less safe, but were noted to have lower intention for

HPV vaccine compliance.²¹ Furthermore, our results are consistent with those of Tangherlini et al (2016), who found that parents use blog sites to promote anti-vaccination sentiments and encourage each other.²² Our research adds to the literature by further examining the discussion between bloggers and readers through an analysis of comments, as well as charting the shift in commenters' perspectives on vaccination over time.

The content of the blogs in our study, along with the results of Dredze et al. (2016) from Twitter postings, demonstrate that social media is seen by the public as a source of useful information.²³ Among Internet users, 80% seek health information online and 16% of those specifically seek information about vaccination.²⁴ The source of online information, whether it be a news organization, a health organization, or a parenting blog, is not always an indicator of its popularity. Radzikowski et al. (2016) found that Twitter posts on vaccination from news organizations were shared more often than those from health organizations.²⁴ Social media posts related to vaccination are considered more compelling and shared more often on Facebook when they have a clear bottom-line meaning or "gist."²⁵ To the extent that blogs can influence knowledge, attitudes, and behaviors related to vaccination, pediatricians and public health officials should be aware of the potential for widespread misinformation. It is worth underlining our finding that the writing on the most highly rated (and thus most followed) parenting blogger according to Blogmetrics' "Ultimate Rank," Nature Moms

Table 3. Analysis of blog posts by date of publication.

	Total N (%)	2006–2009 N (%)	2010–2012 N (%)	2013–2015 N (%)	p
Total comments	698	360	174	150	
Uses evidence	50 (7.2)	25 (6.9)	16 (9.2)	9 (6.0)	0.506
Strongly encourages vaccination	49 (7.0)	16 (4.4)	11 (6.3)	19 (12.7)	0.003
Strongly discourages vaccination	132 (18.9)	83 (23.1)	28 (16.1)	18 (12.0)	0.008
Mentions...					
Natural remedies to boost immunity	45 (6.4)	19 (5.3)	18 (10.3)	8 (5.3)	0.068
Signs and symptoms of adverse reaction	74 (10.6)	5 (1.4)	0 (0.0)	0 (0.0)	0.278*
Autism	38 (5.4)	24 (6.7)	8 (4.6)	5 (3.3)	0.273
Thimerosal or mercury in vaccines	10 (1.4)	10 (2.8)	0 (0.0)	0 (0.0)	0.010*
Sudden Infant Death Syndrome, Guillain-Barre Syndrome, or other medical condition	46 (6.6)	24 (6.7)	11 (6.3)	10 (6.7)	0.988
Overloading immune system with too many vaccines at once	12 (1.7)	3 (0.8)	4 (2.3)	5 (3.3)	0.105*
Herd immunity	4 (0.6)	0 (0.0)	0 (0.0)	2 (1.3)	0.048*
Risk of illness being less than risk of adverse reaction	10 (1.4)	7 (1.9)	1 (0.6)	2 (1.3)	0.585*
Risks not being fully disclosed or understood	7 (1.0)	7 (1.9)	0 (0.0)	0 (0.0)	0.042*
Delaying vaccination from recommended scheduling	33 (4.7)	14 (3.9)	7 (4.0)	12 (8.0)	0.121
Political immunization mandates for school entry	22 (3.2)	8 (2.2)	8 (4.6)	5 (3.3)	0.293*
Condescending attitudes of doctors when refusing vaccines	26 (3.7)	20 (5.6)	4 (2.3)	2 (1.3)	0.037
Trusting doctors' opinions and recommendations toward vaccines	18 (2.6)	10 (2.8)	4 (2.3)	3 (2.0)	0.948*
Profit motivations of pharmaceutical industry	22 (3.2)	13 (3.6)	3 (1.7)	5 (3.3)	0.532*
Distrust of government	23 (3.3)	15 (4.2)	2 (1.1)	6 (4.0)	0.171
Entanglement of government and pharmaceutical industry	29 (4.2)	15 (4.2)	8 (4.6)	6 (4.0)	0.968

N = 16 blog posts in 2006–2009; N = 16 posts in 2010–2012; N = 12 posts in 2013–2015

*Fisher-exact test used instead of chi-square test.

Blog is also the most vehemently and prolifically anti-vaccination. The extent to which such blogs can shape health decision-making around vaccination should not be underestimated.

Our results suggest that some of the negative ideas about vaccines, such as efficacy and safety, can be directly addressed by the expertise of pediatricians. In fact, evidence shows that health care providers generally have a positive influence on parents in encouraging vaccination.²⁶ The American Academy of Pediatrics Committee on Bioethics advises that pediatricians take an understanding and respectful approach when addressing reasons for vaccine hesitancy with patients, as it is a complex topic.²⁷ Our results demonstrating great anti-vaccination sentiments on parenting blogs support the idea that such a framework could be a helpful tool to be used by healthcare providers when talking to hesitant parents.²⁸

Furthermore, although anti-vaccination sentiments proliferate on the Internet, social media can also be used to increase understanding of vaccines and disease prevention. Preliminary results of a 2013 study suggest that a mobile application designed to educate the public about invasive pneumococcal disease was successful in increasing public awareness and prevention through a risk checker.²⁹ Our findings suggest that because individuals seek information about and advice regarding vaccination in the parenting blogosphere, this may be an important target for public health interventions.

While much of the discussion in the parenting blogs and comments that we examined suggests that parents remain concerned about the safety and efficacy of vaccines, it is also clear from our analysis that vaccination remains a highly-charged issue in the United States that reflects larger political tensions. There is an age-old debate regarding whether vaccination is a matter of personal choice and an individual liberty or is a matter of public health law best overseen by the government.³⁰ Despite evidence that vaccination is a true public health success, there remains strong resistance to vaccination discussed in all levels of US politics.³¹ As seen in this study, many parents

who are using this cohort of blogs to express their feelings are taking an anti-vaccination standpoint for reasons such as concern over the relationship between the government and the pharmaceutical industry and infringement on individual liberty. These reasons have been outlined in other studies as primary reasons for vaccine hesitancy.^{28,32,33} The notion of “to each his own,” while perfectly understandable within our social, political, and economic context, is weakened in the context of public health realities. The facts of community or herd immunity³⁴ demonstrate that vaccination against infectious disease is never a solely personal decision within the context of public health. Health care providers and the scientific community need organized efforts to fight vaccine hesitancy.³⁵ This is especially true given that we are in an era where consensus on public health priorities could be challenged.

With that said, our analysis of blog comments by date of blog publication suggests that there has been a shift away from vehement anti-vaccine stances. While 23.1% of comments on blog posts from 2006–2009 strongly discourage vaccination, the percentage decreased to just 12.0% for posts published from 2013–2015 ($p = 0.008$). Still, specific blogs have continued to publish anti-vaccination posts. Nature Moms Blog, the most highly ranked blog and the one with the greatest number of comments, is highly influential and published posts discouraging vaccination as recently as 2013.

This study is limited in that it is cross-sectional, and as such, the findings from these selected parenting blogs cannot be generalized to all parenting blogs. In addition, the popularity ranking of these particular blogs is not static and may change over time. Nevertheless, this study filled a gap in literature by describing the content on the most popular parenting blogs. These findings indicate that there is a need for public health professionals to (1) understand the concerns being expressed in these forums, and (2) develop innovative ways to dispel myths being expressed and viewed by the public, as these views may create obstacles in meeting the goals of the public health agenda.

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No potential conflict of interest was reported by the authors.

References

- [1] Centers for Disease Control and Prevention (CDC). Ten great public health achievements - United States, 1900-1999. *MMWR Morb Mortal Wkly Rep* 1999; 48(12):241-3; PMID:10220250
- [2] Centers for Disease Control and Prevention (CDC). History of Vaccine Safety. 2015 Sept 29. [accessed 2017 Feb 8]. <https://www.cdc.gov/vaccinesafety/ensuringsafety/history/index.html>
- [3] American Academy of Pediatrics. Do immunizations really work? 2015 Nov 21. [accessed 2017 Feb 8]. <https://www.healthychildren.org/English/safety-prevention/immunizations/Pages/Do-Immunizations-Really-Work.aspx>
- [4] Centers for Disease Control and Prevention (CDC). Possible side-effects from vaccines. 2016 Dec 2. [accessed 2017 Feb 8]. <http://www.cdc.gov/vaccines/vac-gen/side-effects.htm>
- [5] Ellenberg SS, Chen RT. The complicated task of monitoring vaccine safety. *Public Health Rep* 1997; 112(1):10-21; PMID:9018282
- [6] Blume S. Anti-vaccination movements and their interpretations. *Soc Sci Med* 2006; 62(3):628-42; PMID:16039769; <https://doi.org/10.1016/j.socscimed.2005.06.020>
- [7] Salmon D, Dudley M, Glanz J, Omer S. Vaccine hesitancy: causes, consequences, and a call to action. *Vaccine* 2015; 33:D66-71; PMID:26615171; <https://doi.org/10.1016/j.vaccine.2015.09.035>
- [8] American Academy of Pediatrics. Common parental concerns. 2016 Aug. [accessed 2017 Feb 8 2017]. <https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/immunization/Pages/Common-Parental-Concerns.aspx>
- [9] Zimmerman R, Wolfe R, Fox D, Fox J, Nowalk M, Troy J, Sharp L. Vaccine criticism on the World Wide Web. *J Med Internet Res* 2005; 7(2):e17; PMID:15998608; <https://doi.org/10.2196/jmir.7.2.e17>
- [10] Wolfe R, Sharp L, Lipsky M. Content and design attributes of anti-vaccination web sites. *JAMA* 2002; 287:3245-8; PMID:12076221; <https://doi.org/10.1001/jama.287.24.3245>
- [11] Jones AM, Omer SB, Bednarczyk RA, Halsey NA, Moulton LH, Salmon DA. Parents' source of vaccine information and impact on vaccine attitudes, beliefs, and nonmedical exemptions. *Adv Preventive Med* 2012; 2012:932741; PMID:23082253; <https://doi.org/10.1155/2012/932741>
- [12] Davies P, Chapman S, Leask J. Antivaccination activists on the world wide web. *Arch Dis Child* 2002; 87:22-6; PMID:12089115; <https://doi.org/10.1136/adc.87.1.22>
- [13] Bragazzi NL, Barberis I, Rosselli R, Gianfredi V, Nucci D, Moretti M, Salvatori T, Martucci G, Martini M. How often people google for vaccination: Qualitative and quantitative insights from a systematic search of the web-based activities using Google Trends. *Hum Vaccin Immunother* 2016; 13(2):464-9 1-6. [Epub ahead of print]
- [14] Brunson EK. The impact of social networks on parents' vaccination decisions. *Pediatrics* 2013; 131(5):e1397-404; PMID:23589813; <https://doi.org/10.1542/peds.2012-2452>
- [15] Wilson K, Keelan J. Social media and the empowering of opponents of medical technologies: the case of anti-vaccinationism. *J Med Internet Res* 2013; 15(5):e103; PMID:23715762; <https://doi.org/10.2196/jmir.2409>
- [16] Centers for Disease Control and Prevention (CDC). CDC social media tools. 2016 Dec 14. [accessed 2017 Feb 8]. <http://www.cdc.gov/SocialMedia/Tools/>
- [17] Amicizia D, Domnich A, Gasparini R, Bragazzi NL, Lai PL, Panatto D. An overview of current and potential use of information and communication technologies for immunization promotion among adolescents. *Hum Vaccin Immunother* 2013; 9(12):2634-42; PMID:23954845; <https://doi.org/10.4161/hv.26010>
- [18] Basch CH, Basch CE, Zybert P, Reeves R. What do widely-viewed YouTube videos say about vaccines? *Child Care Health Dev* 2017; [Epub ahead of print]; 1-5
- [19] Dedoose [Qualitative software]. [accessed 2017 Feb 9]. www.dedoose.com
- [20] Kata A. Anti-vaccine activists, Web 2.0, and the postmodern paradigm - an overview of tactics and tropes used online by the anti-vaccination movement. *Vaccine* 2012; 30(25):3778-89; PMID:22172504; <https://doi.org/10.1016/j.vaccine.2011.11.112>
- [21] Nan X, Madden K. HPV vaccine information in the blogosphere: how positive and negative blogs influence vaccine-related risk perceptions, attitudes, and behavioral intentions. *Health Commun* 2012; 27(8):829-36; PMID:22452582; <https://doi.org/10.1080/10410236.2012.661348>
- [22] Tangherlini TR, Roychowdhury V, Glenn B, Crespi CM, Bandari R, Wadia A, Falahi M, Ebrahimzadeh E, Bastani R. "Mommy Blogs" and the vaccination exemption narrative: results from a machine-learning approach for story aggregation on parenting social media sites. *JMIR Public Health Surveill* 2016; 2(2):e166; PMID:27876690; <https://doi.org/10.2196/publichealth.6586>
- [23] Dredze M, Broniatowski DA, Smith MC, Hilyard KM. Understanding vaccine refusal: why we need social media now. *Am J Prev Med* 2016; 50(4):550-2; PMID:26655067; <https://doi.org/10.1016/j.amepre.2015.10.002>
- [24] Radzikowski J, Stefanidis A, Jacobsen KH, Croitoru A, Crooks A, Delamater PL. The measles vaccination narrative in Twitter: a quantitative analysis. *JMIR Public Health Surveill* 2016; 2(1):e1; PMID:27227144; <https://doi.org/10.2196/publichealth.5059>
- [25] Broniatowski DA, Hilyard KM, Dredze M. Effective vaccine communication during the disneyland measles outbreak. *Vaccine* 2016; 34(28):3225-8; PMID:27179915; <https://doi.org/10.1016/j.vaccine.2016.04.044>
- [26] Smith PJ, Kennedy AM, Wooten K, Gust DA, & Pickering LK. Association between health care providers' influence on parents who have concerns about vaccine safety and vaccination coverage. *Pediatrics* 2006; 118(5):e1287-92
- [27] Omer SB, Salmon DA, Orenstein WA, deHart MP, Halsey N. Vaccine refusal, mandatory immunization, and the risks of vaccine-preventable diseases. *N Engl J Med* 2009; 360(19):1981-8; PMID:19420367; <https://doi.org/10.1056/NEJMsa0806477>
- [28] Domachowske JB, Suryadevara M. Practical approaches to vaccine hesitancy issues in the United States: 2013. *Human Vaccin Immunother* 2013; 9(12):2654-7; <https://doi.org/10.4161/hv.26783>
- [29] Panatto D, Domnich A, Gasparini R, Bonanni P, Icardi G, Amicizia D, Arata L, Bragazzi NL, Signori A, Landa P, et al. Development and preliminary data on the use of a mobile app specifically designed to increase community awareness of invasive pneumococcal disease and its prevention. *Hum Vaccin Immunother* 2016; 12(4):1080-4; <https://doi.org/10.1080/21645515.2015.1114196>
- [30] Mariner WK, Annas GJ, Glantz LH. Jacobson v Massachusetts: it's not your great-great-grandfather's public health law. *Am J Public Health* 2005; 95:581-90; PMID:15798113; <https://doi.org/10.2105/AJPH.2004.055160>
- [31] Callender D. Vaccine hesitancy: more than a movement. *Hum Vaccin Immunother* 2016; 12(9):2464-8; PMID:27159558; <https://doi.org/10.1080/21645515.2016.1178434>
- [32] Black S, Rappuoli R. A crisis of public confidence in vaccines. *Sci Transl Med* 2010; 2(61):61mr1; PMID:21148125; <https://doi.org/10.1126/scitranslmed.3001738>
- [33] Rosselli R, Martini M, Bragazzi NL. The old and the new: vaccine hesitancy in the era of the Web 2.0. Challenges and opportunities. *J Prev Med Hyg* 2016; 57(1):E47-50 PMID: 27346940
- [34] Anderson RM, May RM. Immunisation and herd immunity. *Lancet* 1990; 335(8690):641-5; PMID:1969023; [https://doi.org/10.1016/0140-6736\(90\)90420-A](https://doi.org/10.1016/0140-6736(90)90420-A)
- [35] Siddiqui M, Salmon DA, Omer SB. Epidemiology of vaccine hesitancy in the United States. *Hum Vaccines Immunother* 2013; 9(12):2643-8; <https://doi.org/10.4161/hv.27243>