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Vaccine Confidence in the Online Environment

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2014

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Global Health
2017

Abstract

Vaccine Confidence in the Online Environment
By Rachel Elizabeth Swart

Background: In recent years, parents have become more concerned about the potential for an adverse reaction to a vaccine than vaccine-preventable diseases. This is contributing to the increase in unvaccinated children. The internet has changed the vaccine landscape with the ability to disseminate rapidly both accurate and inaccurate information about vaccines. The internet has influenced parents and has led them to either have high, low or no confidence in vaccines. From December 2014 to April 2015, there was a measles outbreak in California that led to a multiple state outbreak where the exposure originated from Disneyland in California. By February 11, 2015, there were 125 cases of measles (Zipprich, 2015). The purpose of this study was to therefore understand the online information environment in this context and its potential influence on vaccine attitudes, knowledge, and information-seeking patterns.

Methods: To better understand of what people used internet search engine queries for, from looking at California and the United States during the 2014-2015 measles outbreak, Google Trends and Google Correlate were used. Google Correlate was used to find search patterns that related to trends about vaccine confidence and the measles outbreak. Google Trends was used to form graphs based on ten of the terms from Google Correlate.

Results: Google Trends graphs for the United States and the state of California were similar. Although the spikes for searches either started earlier or continued to be searched for a longer period of time in California. Google Trends related queries were similar to Google Correlate searches. These searches surrounded the issues of the 2014-2015 measles outbreak. Google Correlate searches were more confined to wanting to know more about vaccines, as well as being more specific with the Measles Mumps and Rubella vaccine. There were also some searches that pertained to the anti-vaccination movement.

Conclusion: “Infodemiology” is when search engine queries are used as a form of surveillance. Using search engine queries and social media as a form of surveillance can assist with monitoring of a potential outbreak of an infectious disease (Woo, 2016). In the future, the use of Google Trends along with social media can act as an early form of surveillance for infectious diseases. This form of surveillance has already been used for seasonal influenza and should be put to use to track other potential infectious disease outbreaks (Kelly, 2013).

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Acknowledgements

My sincere thanks and gratitude to my advisor Dr. Robert Bednarczyk, for his continuous support of my thesis and research, for his patience, encouragement and his boundless knowledge. His guidance helped me in every aspect of my research and writing of my thesis. I could not have imagined having a better advisor and mentor for my vaccine research.

Besides my advisor Dr. Robert Bednarczyk, I would like to thank my committee co-chair Dr. Paula Frew, for her encouragement and insightful comments. Without her passion and participation, this project would not have been successfully completed.

This study was supported via a grant from the Department of Health and Human Services and the National Vaccine Program Office, 1VSRNV000003-01-00, "Understanding and Addressing Vaccine Confidence and Hesitancy to Foster Informed Vaccine Decision Making." (Paula Frew Principle Investigator)

Finally, I would like to thank my parents, for their unconditional love, their encouragement and support during my research and writing of this thesis.

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Chapter 1-Background

Background

In recent years, we have transitioned to a ‘post-trust’ situation for vaccines, which means that the public does not have trust in the regulations or industries without questions (Holt, 2016). Practically, this means that the public sees the risks of vaccines differently than those who are in the medical field (Holt, 2016). People have demanded that the traditional, paternalistic style of medicine, where patients are expected to do everything their doctor tells them to do, be replaced with a condition of full transparency, where medical care is based around having a two-way conversation between the doctor and the patient (Larson, 2013). Parents have questions about vaccinating their child, just as they have other questions about their child’s health, and these questions need to be heard and answered to create a trust between the doctor and the parent (Larson, 2013). Concerns have been expressed that pressuring parents to vaccinate their child can be seen as forceful and may lead to increased vaccine hesitance (Larson, 2013), leading to beliefs such as “the patient voice will take an increasingly important role in vaccine communication both in the social media sphere and the consulting room” (Holt, 2016).

With the rise in use of the internet, the vaccine landscape has changed, through with the ability to spread accurate and inaccurate information about vaccines (Larson, 2013). Web 2.0 is a way for people to interact on the internet through the use of two-way communication (Betsch, 2012). According to the Pew Research Center, in 2016, 68% of adults living in the United States use the internet. The five most common uses of the internet are: Facebook, Instagram, Pinterest, LinkedIn, and Twitter (Greenwood, 2016). 79% of adults use Facebook and while the highest percentage of those who use Facebook are between 18-29, the next highest are those between 30-49, who are also at the presumed age of most parents with young children (Greenwood, 2016).

32% of adults have reported to use Instagram, 31% use Pinterest, 29% use LinkedIn, and 24% use Twitter (Greenwood, 2016).

Web 2.0, also known as social media, has allowed numerous numbers of people to communicate and share material such as health information (Betsch, 2012). Information can be spread on social media websites extremely fast without being fact checked or with no assessment as to how the information can be interpreted (Holt, 2016). As reported by a *Business Insider,* article in August of 2015 63.8% of those living in the United States use the search engine Google to obtain information (O'Reilly, 2015), and it has been documented that many of their searches about vaccines have been about the link between autism and the Measles Mumps and Rubella (MMR) vaccine (Betsch, 2012). According to the Pew Research Center in 2013, around 35% of adults living in the United States have used the internet to look up a medical condition they or someone else might have (Fox, 2013).

Social media allows both sides of the vaccine arguments to create an influence on people who are researching vaccines on the internet (Larson, 2013). These groups are well organized, and have a rapid growth through means of communicating, networking and coordinating (Betsch, 2012). Anti-vaccination groups' websites focus on adverse events relating to vaccines that are both true and alleged events (Betsch, 2012). Often, personal narratives about adverse events relating to vaccines are one of the many methods that anti-vaccination groups use to spread the message that vaccines are a danger (Betsch, 2012). This uses elements that make the message easy to remember such as: the story is easy to comprehend, it comes from a first person account so it is credible, and the narratives are usually very emotional (Betsch 2012). Parents who already see vaccines as being a high risk are more likely to search the internet for information about vaccines as well as seek out narrative accounts about vaccines, more so than any other type of parent (Betsch, 2012).

Anti-vaccine websites can harm the potential to vaccinate because of the content (Betsch, 2010). Parents looking at anti-vaccine websites can significantly increase their perception of vaccinations being a health risk to their children (Betsch 2010). Parents who seek out information on anti-vaccine websites have lower intentions to vaccinate their children. In a study by Betsch et al, the researchers found that getting information about vaccines on anti-vaccine websites can significantly decrease the intention to vaccinate (Betsch, 2010). Parents who believe in traditional medicine who view vaccine information on anti-vaccine websites are still prone to being influenced by these websites (Betsch 2010). Parents who seek alternative medicine might be more prone to the influences of viewing anti-vaccine websites (Betsch, 2010).

With so many narratives on the internet, parents can misinterpret the reality of adverse vaccine events, due to coming across so many negative events (Betsch, 2012). The more negative narratives a parents reads the greater they see the risk of vaccinating their child (Betsch, 2012). The internet has the ability to influence parents' decisions on whether to vaccinate or not vaccinate their children based on the information they find (Betsch, 2012).

According to Roush, before 1980 there was a 92% decrease of cases of vaccine-preventable diseases and 99% or higher decrease in deaths related to those prevented by vaccines (Roush, 2007). Among children with exemptions from school-entry vaccination mandates most children (75.5%) are exempt from only selective vaccines, which suggests that parents are choosing which vaccines to give their children compared to outright refusing to vaccinate their children (Salmon, 2005). Parents who either refuse or delay vaccines are more likely to use the internet as well as not trust information pertaining to vaccines from their doctors, health departments or the government (Shoup, 2015). Parents are also not as likely to see the benefits of vaccines, look for information elsewhere and have their children be exempt from vaccines (Jones, 2012).

People who seek information about vaccines on the internet do not always have an anti-vaccination sentiment, they may just want answers to their questions surrounding vaccination (Larson, 2011). Most of the information on the internet related to vaccination contains anti-vaccine sentiments and may use scientific like language to sound legitimate (Jones, 2012). The internet has assisted the anti-vaccination movement and has allowed them to spread their message to a larger audience (Larson, 2011). The websites used by the anti-vaccination movement spread incorrect information that vilifies the medical field and creates fear among the public (Shoup, 2015). Parents who use the internet for vaccine information, are purposely searching for alternative opinions to the traditional medical view on vaccines (Jones, 2012).

Those parents who are seeking alternatives to medicine may be more likely to listen to or consider the opinions of chiropractors, acupuncturists or other complementary/alternative medicine, also known as CAM (Salmon, 2005). CAM is not part of the traditional healthcare, and has risen in popularity (Bleser, 2016). Data from the previous decade show that about one-third of people in the United States have used at least one type of CAM in the last twelve months (Bleser, 2016). CAM is mostly used as an addition to traditional medicine and therefore should not influence vaccine opinions (Bleser, 2016).

Although it may be true, CAM professionals also have supported anti-vaccine or vaccine hesitant views (Bleser, 2016). Many CAM professionals, even those who agree with vaccines recommend a different schedule for vaccines than that recommended by the Centers for Disease Control and Prevention (Bleser, 2016). CAM use for children is common and literature shows that kids who use CAM are less likely to be vaccinated (Bleser, 2016). Most children who use CAM professionals are those who are non-Hispanic white, who have parents with high levels of education, are not poor and have private health insurance (Bleser, 2016). Certain CAM professionals such as naturopathy and chiropractic have negative views of vaccines and advise parents on not vaccinating their kids (Bleser, 2016). Parents see these type of professionals as a more credible source of vaccine information and may even use these professionals as their child's main source of health care (Salmon, 2005).

Some anti-vaccination websites are not just dedicated to the refusal of vaccines but present a broader selection of topics about parenting and child-rearing (Tangherlini, 2016). These so called "mommy blogs" do not have a moderator therefore the material being provided about health information may not be correct due to a lack of consistent fact checking (Shoup, 2015). Vaccination is a common topic on these blogs (Tangherlini, 2016). "Mommy blogs" expose parents to the ideas that vaccines are a threat and that by refusing to vaccinate your child is a way to stop the threat (Tangherlini, 2016). Parents searching for information about vaccines on the internet who come across websites that have anti-vaccine sentiments, no matter their opinion, may increase their perception that vaccines are a risk and decrease their intent to vaccinate their child (Guidry, 2015 and Tangherlini, 2016).

Measles, which is one of the oldest vaccine-preventable diseases and can affect both children and adults (Avila-Aguero, 2015). While, most people can make a full recovery from measles, there are life-threatening health effects that can occur and kill infants, pregnant women and the elderly (Avila-Aguero, 2015). Measles is highly contagious and outbreaks are common and can be an extensive public health problem (Avila-Aguero, 2015). In order to prevent measles outbreaks in the United States, the vaccine coverage rate needs to be above 95% (Avila-Aguero, 2015). In 2002, in the Americas endemic transmission of measles was eliminated. This was due to high coverage rates of the 2 dose of the MMR vaccine since 2000 (Avila-Aguero, 2015).

However, measles is still endemic to other parts of the world and outbreaks have occurred when unvaccinated people have come into contact with someone who has the measles (Avila-Aguero, 2015). Even though the United States has high coverage of the MMR vaccine, the United States still experiences outbreaks of the measles due to imported cases (Bednarczyk, 2015). Herd immunity has assisted with keeping the number of outbreaks low in the United States, but there has been a decrease in the perceived risk of the measles. Now, people tend to focus on the adverse reactions that could occur from the vaccine which has led to an increased number of people refusing or delaying the MMR vaccine (Omer, 2009).

MMR vaccine levels need to remain high in the United States to ensure adequate herd or "community immunity"; without this safety net, there is potential for additional cases of the measles that could result in micro epidemics (Bednarczyk, 2015). Not all children are vaccinated and this can lead to more children being possibly exposed to the measles (Bednarczyk, 2015). Unprotected children can be those too young to get vaccinated, got vaccinated at a later age, their immunity was altered because of immunosuppression or the vaccine did not invoke a protective immunity (Bednarczyk, 2015). According to Bednarczyk et al, immunity for children who are 17 or younger is around 92% in the United States (Bednarczyk, 2015). While 92% are vaccinated, 8.7 million children who are under the age of 17 are susceptible to measles and this means that there is a potential for a large scale measles outbreak (Bednarczyk, 2015).

The United States experienced a major multiple state outbreak from measles that started in late December of 2014 in California (Avila-Aguero, 2015). This outbreak was a huge threat to the control of measles in the Americas (Avila-Aguero, 2015). The media proclaimed that unauthorized immigrants were bringing in measles, it was false and instead it was either a United States resident who traveled to a region where measles was endemic or an international traveler visiting the United States from a region where measles was endemic (Bednarczyk, 2016). Most countries where unauthorized immigrants originate from, have high rates of the 1st dose of the MMR vaccine and low rates of the measles virus (Bednarczyk, 2016).

Residents from the United States who visit high income countries around the world, these countries have low rates of the 1st dose of the MMR vaccine and have large outbreaks of the measles (Bednarczyk, 2016). The top 10 places residents of the United States visited in 2014 were: Mexico, Canada, UK, Dominican Republic, France, Italy, Germany, Jamaica, Spain and China (Bednarczyk, 2016). The top 10 places international visitors travel from are: Canada, Mexico, UK, Japan, Brazil, China, Germany, France, South Korea and Australia (Bednarczyk, 2016). Bednarczyk, 2016 recommends that all residents of the United States who travel should be up to date on their vaccines before leaving the country. Notably, the United States recommendations are in place to ensure achievement of higher rates of vaccine coverage for its residents, to protect its residents from imported cases of measles (Bednarczyk, 2016).

With so few studies that determine the effect that the internet has on vaccine confidence, there is a need to address the gap in knowledge of patterns surrounding internet searches in vaccine confidence. Therefore, I used Google Correlate and Google Trends to evaluate terms, phrases, and patterns on the internet to better understand vaccine confidence. I also used Google Correlate and Google Trends to get a better understanding on the Disneyland California measles outbreak and how California and the United States differed.

Purpose Statement

The purpose of this study is to explore vaccine confidence on the online environment in the United States, and to understand how the online environment changes vaccine confidence levels. This study also explored the online searches of vaccine related information for both California and the United States during the California Disneyland measles outbreak.

Research Questions

1. How does the online environment affect vaccine confidence?

2. What are the characteristics of those who have low vaccine confidence and high vaccine confidence? Do the two groups look different?

3. Do Google searches differ between California and the United States during the Measles Outbreak?

Significance

With the number of unvaccinated children growing, there is a need to understand how the online environment influences the choices that parents and guardians make concerning their children. It is also necessary to recognize that there are different types of vaccine confidence that occur. This study will evaluate terms associated with vaccine confidence to provide a mean to determine the varying levels of influence that the online environment has, as well as a better understanding on online searches during a vaccine-preventable disease outbreak.

Chapter 2- Literature Review

The impact of vaccines

Vaccines are considered one of the most important achievements of the twentieth century as well as being one of the most effective tools in the field of public health. Vaccines have reduced both morbidity and mortality from infectious diseases (Bean, 2011 and Orenstein, 2015). It is estimated that the use of vaccines prevents around three million deaths per year (Bean, 2011). In a letter by Bill and Melinda Gates, they write that "for every dollar spent on childhood immunizations, you get $44 in economic benefits" (Saunders, 2017). Benefits can include saving the family money they may lose if their child is sick and a parent has to stay home and take care of said child (Saunders, 2017).

Additionally, other literature indicates that vaccines for children will prevent around 42,000 deaths as well as 20 million cases of vaccine-preventable diseases. It will also save $13.5 billion for direct costs and $68.8 billion for societal costs (Zhou, 2014). Therefore, vaccines have the ability to alleviate suffering, save the lives of countless children as well as cut healthcare spending (Salmon, 2015).

The increased use of vaccines has led to a steady decline in vaccine preventable diseases (Bean, 2011). With the increase of vaccines for many childhood diseases, younger parents are not as familiar with the diseases, which has led to these parents moving away from fearing the disease to fearing the reaction to the vaccine (Salmon, 2015). This has led to parents or other groups questioning if the risk of vaccines is a real benefit (Larson, 2014). Therefore, there are some instances of lower rates of vaccination which can result in outbreaks of vaccine preventable diseases (Bean, 2011).

According to Chen and Orenstein, "disease outbreaks in a vaccinated population can raise doubts as to the efficacy of the vaccine and the vaccination program. Such outbreaks may result from accumulation of susceptible persons from: 1) lack of vaccination, 2) primary vaccine failures (persons vaccinated but not immunized), and/or 3) secondary vaccine failures (persons successfully immunized initially but whose immunity subsequently wanes)" (Chen, 1996). While there are a few vaccine preventable disease outbreaks, vaccination is still the norm in the United States (Salmon, 2015).

Below are the three key concepts surrounding vaccine issues: confidence, hesitance, and refusal. Table 12. was constructed that has the three terms, their definitions, and examples of the types of parents.

What is vaccine confidence and vaccine hesitance

Vaccine confidence

Vaccine confidence has multiple components, with different definitions identified by MacDonald (MacDonald, 2015) and the National Vaccine Advisory Committee report (Orenstein, 2015). There can be differences in confidence, in having confidence in the vaccine itself and having confidence in the vaccination system. One proposal to define this phrase was developed by MacDonald, vaccine confidence is influenced by three components: confidence, complacency and convenience (MacDonald, 2015). Confidence means to have trust: in the safety and effectiveness of vaccines, in the systems that delivers the vaccines which include the reliability and competence of the health services as well as the health care workers, and in the motivations that policy makers who decide on the vaccines (MacDonald, 2015). Complacency is when people accept the need to vaccinate without a strong opinion either way (MacDonald, 2015) . Convenience is when the vaccines are available, affordable and there is a willingness to pay as well as go to the location where the vaccine is being offered. This also includes the quality of service at the location as well as the information being delivered in a culturally competent way (MacDonald, 2015).

In the National Vaccine Advisory Committee report, vaccine confidence was defined as including parents trust in: the recommended immunizations, in the provider who is administering the vaccine, and those who license the vaccines as well as those who make the recommended vaccine schedule (Orenstein, 2015). In this definition confidence can be determined using four factors which are; trust, attitudes and beliefs, healthcare provider confidence in both the vaccine and the ability to communicate effectively to the parents about vaccines, and the information environment surrounding vaccines (Orenstein, 2015).

Sometimes the phrase vaccine acceptance will be used instead of vaccine confidence, which is defined as "timely receipt of all childhood vaccines as recommended by ACIP when vaccines and vaccine services are available (Orenstein, 2015)". People do not have to have confidence in the vaccine but can still accept the vaccine based on the feeling that they need to be vaccinated. In other words, a parent may have questions about vaccinating their child, but will vaccinate their child. This is what vaccine acceptance can look like, not having confidence in the vaccine but be vaccinated.

Vaccine hesitance

Vaccine hesitance is defined as "delay in acceptance or refusal of vaccination despite availability of vaccination services" (MacDonald, 2015). Vaccine hesitance has a much wider net than vaccine confidence and includes factors such as immunization services, time, place, fear of needles, and a lack of concern about vaccine-preventable diseases (MacDonald, 2015). As shown, vaccine hesitance is a spectrum that goes from one end, of accepting all vaccines but questioning them, to the other end, of refusing all vaccines (Larson, 2014).

While vaccine rates are high, there are a growing number of parents who have concerns about vaccine safety (Gust, 2008). This is partly due to the decrease in seeing the "once common childhood illnesses" and the need to have vaccine ingredients have a high standard of safety (Gust, 2008). There are different parental attitudes for vaccines. These attitudes can range from being advocates of immunization, parents who go along with what their doctor tells them, parents who are advocates of health and seek vaccine information, those who sit on the fence, and finally parents who are worried about adverse vaccine reactions (Salmon, 2015).

Parents can show doubt three ways. First, they vaccinate their kids but are not sure if it was the best thing to do. Second, delay immunization. Third, decide not to immunize their child (Gust, 2008). Most parents who delayed vaccines did so because at the time their child was sick and thus are categorized as different than unsure or refused. Most parents who delayed vaccines did so, with not a specific vaccine and they mostly delayed vaccines because their child was sick at the time of the appointment. This shows that parents who delay for a sick child are different than those who are vaccine hesitant. These parents are more concerned about the potential harmful effects the vaccine could have on their sick child rather than actual vaccine safety issues (Gust, 2008).

There has been a shift moving away from fearing the diseases to fearing the vaccine reactions. One of the most feared vaccine reactions is autism (Salmon, 2015). In the past 20 years there has been an increase in prevalence of autism and those who are vaccine hesitant made the connection that the increased number of cases can be related to the increasing number of vaccines given to children under the age of two (Salmon, 2015).

What is vaccine refusal

Vaccine refusal is easier to measure due to the fact that you can identify those who choose not to vaccinate. Although that may be the case, the refusal to vaccinate is based on issues that come from confidence and hesitance. The concerns about vaccines can be placed into two categories-the perception of risk and safety of the vaccine and the rights and responsibilities as citizens in a community (Blume, 2006). There needs to be a balance between being an informed citizen who makes one's own choice and being told to be vaccinated (Blume, 2006).

Those who refuse vaccines have a certain perception on the susceptibility and severity of the disease, they lack trust in the safety and effectiveness of vaccines as well as mistrust in those who work in the healthcare field and in the government (Salmon, 2015). Other beliefs of those who refuse vaccines think that: adverse reactions to vaccines are underreported; vaccines can lead to idiopathic illness such as autism; vaccines only provide a temporary immunity to the disease at hand; drug companies profit on selling vaccines; the need to vaccinate to go to school is a violation of civil liberties; diseases that the vaccines prevent are already on the decline; and the way to improve health is through holistic means (Blume, 2006).

Parents may choose not to vaccinate their children based upon the perception that vaccines can cause illnesses, that they are ineffective as well as being part of a conspiracy that includes the medical field, pharmaceutical companies and the government (Kata, 2011). They also believe that too many vaccines at once may cause harm to their child or overwhelm their immune system (Kata, 2011). Parents feel that the information provided by both the medical field and the government while it is legitimate it is only one-sided information (Kata, 2011). This leads to parents seeking out information on the internet about vaccines and parents find themselves on websites that promote vaccine refusal which uses incorrect information to advocate the refusal of vaccines (Kata, 2011).

Parental media exposure and under/un-vaccination

With the internet being so popular, many people use the internet to search for health related information (Kata, 2011). This information impacts how people make decisions on their health when talking to their doctor (Kata, 2011). The internet has changed the medical field from the doctor making the decisions about a patient's health to the patient becoming informed and discussing with the doctor what they found on the internet (Kata, 2011). The internet has a plethora of information that is available for people to read. This can lead to people having opinions that they believe allow them to have more weight in their healthcare experience. The internet has made more information about vaccines become available. And this wealth of information can lead parents to go more in-depth in vaccine research which can assist parents in making decisions about whether or not to vaccinate their child. Web 2.0, which allows people to engage with others on the internet, people share more than their health and have started to educate others about health issues including vaccines. Studies have shown that parents who seek out information related to vaccines on the internet are more likely to refuse vaccines for their children than parents who seek information from their doctor (Kata, 2011).

There are many websites on the internet which cater to people who have strong feelings about not vaccinating their children (Kata, 2011). These anti-vaccination messages are more common on the internet compared to any other form of media (Kata, 2009). These websites appeal to those who are searching for information on vaccines which already reinforce their beliefs that refusing vaccinations is right for them (Bean, 2011). The internet is the easiest place where unverified information can be found, which can lead parents to being educated in misinformation about vaccines (Bean, 2011). Anti-vaccination websites spread their information in a very interesting way through the use of camouflaging their true meaning through using phrases such as: vaccine safety, health freedom and informed consent (Kata, 2011). The content on these websites can include: safety/effectiveness, alternative medicine, civil liberties, conspiracy theories or search for the truth, morality/religion/ideology and misinformation/falsehood (Kata, 2009). The anti-vaccination movement has used the internet to spread fear about vaccines thus creating parents who are misinformed (Kata, 2011).

As more people are connected to the internet and social media, the anti-vaccine message can spread further. This can be seen through the likes and shares of different articles found on anti-vaccination websites. An article titled “Our children can be healthy and protected without vaccination”, there was 23,151 Facebook likes/shares, 11 Google+ shares, 81 re-Tweets/shares, 118 people repined it on Pinterest, and there was 37 Facebook comments (Kara, 2015). In another article from the same website, this article titled “Public health myth #4: Herd immunity requires vaccination”, got 3,402 Facebook likes/shares, 2 Google+ shares, 54 re-Tweets/shares, 26 people repined the article and there was 3 Facebook comments (Cook, 2015). These two articles go to show how social media can aid in the spread of the anti-vaccine message and how fast it can spread as well.

California measles outbreak case study

History of measles in the United States prior to the California outbreak

Despite the elimination of measles in the United States, cases still occur due to international travel or visitors who are from the regions where measles are still endemic (Liu, 2015). Before the start of the 2014-2015 measles outbreak (this is what the the outbreak that originated in Disneyland California will be called) in late December of 2014, the United States had low incidences of measles cases. Measles can be spread through aerosolized droplets from an infected person's cough or sneeze and can remain infectious for several hours (Getz, 2016). People who have had the measles receive a near life-long immunity from this disease (Getz, 2016). Many parents refuse vaccines due to concerns about "possible side effects," the diseases that vaccines prevent are not dangerous, and there is a basic distrust of the medical field (Porteous, 2016).

The California measles outbreak

When health officials announced that the Disneyland theme parks in California were connected to the measles outbreak, it "attracted national media attention and served as a reminder of the potential of vaccine-preventable diseases to cause injury" (Porteous, 2016). The 2014-2015 measles outbreak was linked to one or both of the Disneyland theme parks (Blumberg, 2015). The exposure occurred in the theme parks between December 17-20, 2014 (Blumberg, 2015). The exposure could have come from one of Disneyland's many international visitors whose home country could still have endemic cases of measles (Porteous, 2016).

It has been assumed that there were 40 primary cases from California who were exposed during the time period in December (Blumberg, 2015). An additional 91 people from California got the measles as secondary cases (Blumberg, 2015)). Orange County California "has been described as the epicenter of vaccine refusal" (Jacobson, 2015). Between January and April of

2015, over 80% of measles cases from this outbreak were those who were not vaccinated (Jacobson, 2015). According to the Centers for Disease Control and Prevention by February 11, 125 cases of measles had occurred. 110 of the 125 cases were California residents (Zipprich, 2015). Of the 110 cases, 39 visited either one or both of the parks during the time of exposure, 37 cases had an unknown source of exposure and 34 were secondary cases (Zipprich, 2015). Of the 34 secondary cases, 26 of them were either exposed through the household or close contact and the other 8 cases were exposed through the community setting (Zipprich).

Among the California cases, 49 were unvaccinated and 12 of those were too young to be vaccinated. Among the 37 who were not vaccinated, 28 cases were not vaccinated because of personal belief and 1 was on an alternative vaccination plan (Zipprich, 2015). With the 28 measles cases who were unvaccinated due to personal belief, 18 of those were kids and the remaining 10 were adults (Zipprich, 2015). The remaining 15 cases that were not California residents were linked to seven other states: Arizona had 7 cases, Colorado had 1, Nebraska had 1, Oregon had 1, Utah had 3 and Washington had 2 (Zipprich, 2015). There were also 11 cases outside of the United States, 1 case from Mexico and 10 from Canada were linked to the 2014-2015 measles outbreak (Zipprich, 2015). The 2014-2015 measles outbreak can be a reminder that in order to keep outbreaks at bay there is a need to have high vaccination rates all over the United States (Zipprich, 2015).

Aftermath of the California measles outbreak

According to Getz, people should not be surprised that there was an outbreak of measles nor should people think that the 2014-2015 measles outbreak will be the last outbreak to occur. The public needs to be made aware and be prepared if another outbreak were to occur (Getz, 2016). The 2014-2015 measles outbreak highlighted how contagious measles was and that there is a need to keep the herd immunity coverage rates high to decrease the spread of all infectious diseases (Porteous, 2016). This outbreak leads people to believe that herd immunity for measles is in jeopardy in the United States (Buttenheim, 2015). This outbreak transmission rate was relatively consistent with past measles outbreaks in the past decade in the United States (Blumberg, 2015). The 2014-2015 measles outbreak generated a great deal of media attention surrounding the issues and risks of not being vaccinated (Cataldi, 2016). Studies have shown that negative media coverage around vaccines assists with the decline in vaccine rates (Cataldi, 2016). During the 2014-2015 measles outbreak the media coverage was positive and was pro-vaccine (Cataldi, 2016). A study wanted to know if positive news coverage increases the chance of a child getting the MMR vaccine, the study found that new mothers believed that vaccines were important and were more interested in vaccines (Cataldi, 2016). New mothers showed greater interest in the MMR vaccine after the outbreak (Cataldi, 2016). In the study by Cataldi, one woman changed her child's vaccine schedule from a non-recommended plan to the recommended plan after the 2014-2015 measles outbreak ceased (Cataldi, 2016). This shows that during an outbreak there are opportunities for positive communication surrounding the topic of vaccines to assist mothers in making choices about vaccinating their children (Cataldi, 2016).

Assessment of internet usage trends

Google Correlate

Google Correlate is used to find search patterns in real world trends. Google Correlate uses activity from web searches to find the search pattern. Google Correlate is the reverse of Google Trends. In Google Correlate a word or phrase is entered and you receive a list of words or phrases (Google Correlate, 2011).

“Infodemiology”, when search engine queries are allocated for public health surveillance was coined by Eysenbach. Search queries along with social media can aid with traditional methods of monitoring for potential infectious diseases (Woo, 2016). The future can bring the use of Google Trends and Google Correlate as well as social media to measure and track health information and act as an early form of surveillance for an infectious disease. Social media has already assisted with this type of surveillance for the seasonal influenza (Kelly, 2013). In the future, this method should be used to assist with and prevent other infectious disease outbreaks.

Google Trends

Google Trends is a statistical tool that is linked to Google Correlate. Google Trends is used to show how often a search term is entered into Google search. Each search is divided by geography and time range along with popularity. The relative frequency, which is not a direct measure of frequency of searches are on a range from 0-100. This means that 100 does not mean 100,000 searches, just that it was the max seen during that time period and thus it is used as the benchmark for that comparison. The data is from real time and is updated weekly (Google Trends, 2014).

Chapter 3- Manuscript

Abstract

In recent years, parents have become more concerned about the potential for an adverse reaction to a vaccine than vaccine-preventable diseases. This is contributing to the increase in unvaccinated children. The internet has changed the vaccine landscape with the ability to disseminate rapidly both accurate and inaccurate information about vaccines. The internet has influenced parents and has led them to either have high, low or no confidence in vaccines. From December 2014 to April 2015, there was a measles outbreak in California that led to a multiple state outbreak where the exposure originated from Disneyland in California. By February 11, 2015, there were 125 cases of measles (Zipprich, 2015). The purpose of this study was to therefore understand the online information environment in this context and its potential influence on vaccine attitudes, knowledge, and information-seeking patterns.

To better understand of what people used internet search engine queries for, from looking at California and the United States during the 2014-2015 measles outbreak, Google Trends and Google Correlate were used. Google Correlate was used to find search patterns that related to trends about vaccine confidence and the measles outbreak. Google Trends was used to form graphs based on ten of the terms from Google Correlate.

Google Trends graphs for the United States and the state of California were similar. Although the spikes for searches either started earlier or continued to be searched for a longer period of time in California. Google Trends related queries were similar to Google Correlate searches. These searches surrounded the issues of the 2014-2015 measles outbreak. Google Correlate searches were more confined to wanting to know more about vaccines, as well as being

more specific with the Measles Mumps and Rubella vaccine. There were also some searches that pertained to the anti-vaccination movement.

"Infodemiology" is when search engine queries are used as a form of surveillance. Using search engine queries and social media as a form of surveillance can assist with monitoring of a potential outbreak of an infectious disease (Woo, 2016). In the future, the use of Google Trends along with social media can act as an early form of surveillance for infectious diseases. This form of surveillance has already been used for seasonal influenza and should be put to use to track other potential infectious disease outbreaks (Kelly, 2013).

Introduction

There has been a substantial decline in the number of occurrences of vaccine-preventable diseases due to the increased usage of vaccines (Bean, 2011). With the decrease in many of the childhood diseases that vaccines prevent, new parents who are younger and not familiar with the destruction that these diseases can cause have led parents to move away from fearing the disease to now fearing the possible adverse reactions from vaccines (Salmon, 2015). These parents and others have started to question if the risk of vaccines is worth the risk of potentially deadly adverse reactions (Larson, 2014). Vaccine hesitance is a spectrum that goes from one end, of accepting all vaccines but questioning them, to the other end, of refusing all vaccines (Larson, 2014). Parents are starting to raise questions about vaccines and become more hesitant. Therefore, doctors and parents need to create a trust when dealing with questions about vaccines due to the fact that some believe parents have been pressured to vaccinate their children which can be seen as taking away the parents right to choose (Larson, 2013).

The growth of the internet has allowed social media to promote both sides of the vaccine argument and has created people who become influenced when they research vaccines on the internet (Larson, 2013). As parents research and read about the incorrect information that is provided through groups who have anti-vaccination sentiments, these parents see that there is a greater risk of vaccinating their child (Betsch, 2012). There is a gap in the knowledge of what parents are searching for when they use the internet and how these searches are occurring, such as how they are getting to certain websites. There is a need to get more insight into how these websites can influence a parent on the perceptions of vaccines.

Because the internet has become an integrated part of our lives, there is a new way to discuss medical problems. The internet has altered the medical field and led to the patient becoming more involved in the conversation with the doctor due to the information they have found on the internet (Kata, 2011). Parents tend to be skeptical of information given to them from the medical field, and as a consequence, they turn to the internet for their answers (Kata, 2011). This leads to parents searching for the “other side” through the use of the internet. These websites promote incorrect information to advocate for vaccine hesitance or vaccine refusal. To ensure that hesitance of vaccines is addressed in health appointments, there needs to be more conversation between healthcare professionals and parents about the issues surrounding vaccines.

The purpose of this study is to explore vaccine confidence in the online environment in the United States. We need a better understanding of how the internet can change a parent’s view on vaccines. This study evaluated terms related to vaccine confidence in the online environment as well as understand what people search for during a measles outbreak. Google Correlate and

Google Trends were used to evaluate terms, phrases and patterns on the internet to get an improved understanding of vaccine confidence.

Methods

Google search analysis

Google Correlate and Google Trends were used to find internet search engine queries from California and the United States during the 2014-2015 measles outbreak. Google Correlate was used to find search patterns that relate to trends about vaccine confidence. In other words, what are the most common phrases that come up when someone searches for a certain word or phrase relating to vaccines. Google Trends was used to construct graphs based on some of the terms from Google Correlate.

A Microsoft Word table was constructed for the Google Correlate searches. The term being used is on top and the tables are spilt in half with the first half including the search term in the phrases and the second half excluding the search term in the phrases. Each table is from December 2014 to April 2015 and there are two tables for each phrase, one for California and the other for the United States. The first twenty phrases were used for the Google Correlate tables.

Google Trends was used to make graphs of search terms to see the popularity of certain terms over time. An example is, vaccine and autism within the last year. For the graphs displayed below, a specific period of time was between December 1, 2014 and April 30, 2015 and details for that specific term will be explained. Google Trends was also used to look at related queries. Tables were made for this as well. Each table was for the one phrase, with each side being one of the broken down terms. There were two tables for each term one for California and the other for the United States.

Results

Internet search activity around the California measles outbreak

Google Trends was used to make graphs for ten phrases, each of the graphs had two counter partners one being the United States and the other being the state of California. The time period was from December 1, 2014 to April 30, 2015 was used as the start and end dates for the graphs. The ten phrases were: 1) measles; measles vaccine, 2) measles; vaccine, 3) measles vaccine; vaccine safety, 4) measles vaccine; vaccine ingredients, 5) measles vaccine; SB277, 6) SB277, 7) Disneyland measles, 8) measles, 9) measles; Disneyland measles, and 10) measles; Disneyland; Disneyland measles.

Overall the graphs are similar due to the fact that the outbreak occurred within the United States. The spikes of when the phrases were searched start at similar times but continued for longer in California. The larger and longer spikes for California show that there were more google searches going on with the ten phrases used. In the graphs (Graph 1) Measles; Measles vaccine, measles search started on January 22 for the United States as a whole, and on January 15 –7 days earlier—when considering California-based searches independently. Measles search pattern started to decrease overall in the United States on February 18 and for California the measles search pattern started to decrease on February 19, 1 day later. For (Graph 3) Measles vaccine; Vaccine ingredients, the search for vaccine ingredients started on January 31 for the United States as a whole, and on January 11—a difference of 20 days—when considering California-based searches independently. Vaccine ingredients started to decrease overall in the United States on February 15 and for California vaccine ingredients search pattern started to decrease on February 24, a difference of 9 days. Graphs (Graph 5) Measles vaccine; SB 277, SB

277 search started on February 27 for the United States as a whole, and on February 25—2 days later—when considering California-based searches independently. SB 277 search patterns started to decrease overall in the United States and California on April 30. The graphs (Graph 8) Measles, measles search started to decrease on February 18 for the United States as a whole, and on February 27—9 days earlier—when considering California-based searches independently. The search for measles for both started on January 8, with reaching the maximum on February 3 for the overall United States, while in California there were two maximum days for search of measles, the days were January 22 and February 3.

The Google Trends related queries were used to see if these related google searches were different than Google Correlates, and there were some differences. For Google Trends related queries most searches were about where the measles outbreak is (Disneyland), how long the measles vaccine works, who should get the measles vaccine and at what age should one get it. In the first search (measles; measles vaccine) for the United States there was no searches related to looking for symptoms of measles, but in the queries for California there was.

Google Correlate phrases included: measles, vaccine, measles vaccine, vaccine ingredients, and vaccine safety. These searches were again very similar to Google Trends related queries. Although, for these searches, it was more about wanting to know about vaccines and much more specific with the measles and MMR. Some of the data shows that some people were looking up anti-vaccination sentiments such as: vaccine deaths, vaccines and autism, cause autism, vaccine debate, vaccine controversy, why vaccinate, vaccine exemption, and dangers of vaccines.

Discussion

Though low in resources, impoverished people still access healthcare information on the internet. Of the one-third of American adults who use the internet as a way to find information about their health, 37% are white/non-Hispanic, 30% are black/non-Hispanic and 25% are Hispanic (Fox, 2013). These numbers show that white/non-Hispanic use online healthcare information more than black/non-Hispanic or Hispanics. By increasing internet access this can amplify everyone's access to online healthcare information. While this may be the case for internet access on a computer, the ownership of a smartphone is more popular with the Hispanic population 49% and black/non-Hispanic population 47%. This was compared to white/non-Hispanic population 42% (Fox, 2013). Black/non-Hispanic (35%) and Hispanic (38%) populations also use their mobile phone to access healthcare information more than their white/non-Hispanic counterparts (27%) (Fox, 2013). These findings show that while black/non-Hispanic and Hispanic populations have less access to computer internet, they use their mobile phones to access the internet more than the white/non-Hispanic population. Future research may identify internet access and use patterns across different demographics to promote universal access to online healthcare information. This may have implications in the interpretations of the findings presented here. Future assessments of internet search terms related to vaccination or infectious disease outbreaks should include novel methods for assessing sociodemographics to ensure that the population under surveillance is representative of the full population, and that no subgroups are missed during these surveillance activities.

In general, the public have a lack of concern of vaccine-preventable diseases in the United States, because they are uncommon. This leads parents to become more concerned about the adverse reactions to the vaccines than diseases itself, which can contribute to an increase in unvaccinated children (Jones, 2012). Those left unvaccinated can have many harmful health consequences and can easily spread a vaccine-preventable disease (Guidry, 2015). With the uptake in those who have anti-vaccine sentiments, they are impacting numbers needed to prevent an outbreak of an infectious vaccine-preventable disease (Guidry, 2015).

The 2014-2015 measles outbreak case study showed the differences between the United States and California during the outbreak in the same time period. The spikes from the Google Trends graphs differ between the two regions. It speaks at a greater volume that the spikes were also larger and longer for California, which furthermore shows that California was greater affected than the United States in the outbreak. This type of monitoring, especially in the early days of an outbreak, or through the use of routine monitoring for key terms can identify pockets of increased search activity that can be utilized for the most effective surveillance.

To no surprise the results enhanced the knowledge that those who lived in California were more active while searching for answers to measles and the greater United States was more or less searching for information on the current outbreak. Most of the searches start to increase on January 8, 2015. The reasons are on January 7, 2015 the California Department of Public Health, issued a warning that there was a possible link to the measles cases to Disneyland, which aired at night. And on the 8th, news sources from around the United States were making announcements that the measles cases in California were linked to Disneyland. For the January 22, 2015 spike, the day before California announced that there were 59 cases of measles in the state and 42 of them could be linked to Disneyland. The February 3, 2015 spike can be associated with the report that Los Angeles Country reported 21 cases of the measles and that 17 of them could be linked to Disneyland (Moulite, 2015). The spike for April 9, 2015 can be linked with the fact that the day before the California State Senate in the Health committee had passed the SB 277 Bill (California Legislative Information-Bill Votes, 2015). These findings can be used for future validation studies. Specifically, for searches or key words that raise attention through the use of a system that monitors for frequencies of these searches or terms that begin to become common enough to be used for an intervention or for additional surveillance.

In the Google Trends related queries, it comes to no surprise that the symptoms of measles were first searched for in California in Measles; Measles vaccine rather than the United States. This can be due to that while the United States was worried about the measles outbreak, California was in the middle of the outbreak. Overall, the United States searches were more broad than the California searches and California was more refined and wanting direct answers about the measles.

In 2006 Eysenbach first termed the word “infodemiology,” which is the use of search engine queries for utilization of surveillance (Woo, 2016). Understanding patterns of how and when people use search engines may give early warning signs about health issues in the surrounding area (Signorini, 2011). These search queries are sources of information that can be used to detect an emerging outbreak due to the fact that there is an increase volume of certain keywords (Woo, 2016). Studies have shown that people who are sick will use the internet to search for information on their illness, which goes to say the more a health topic is searched for the more interested the public is about said topic (Woo, 2016 & Signorini, 2011). While search queries provide the keywords that are being searched for, there is a need to have context to connect the search and the disease trend (Signorini, 2011). Social media may be the link between search engine queries and the disease trend, social media can give the contextual information behind the searches (Woo, 2016). According to Woo et al, their study found that using social media data to support surveillance for search query data on influenza was useful because social media gave the researchers an idea on the weight of the information surrounding influenza and how helpful it was to get information for search queries based on contextual information from social media (Woo, 2016). Keywords for search queries change all the time and are based on factors such as the media or other events. Search queries and social media can assist with a low-cost and near real-time update on monitoring of a potential outbreak of an infectious disease. These two resources combined have the power to be able to detect an outbreak and may be useful for detecting future pandemics (Woo, 2016).

Once the immediate threat of the measles was over, public perception was not focused on the measles outbreak and thus the searches for words or phrases relating to the measles outbreak in California decreased greatly. A recent study found that as the novelty of the H1N1 pandemic dwelled, people's anxiety about the influenza quelled as well (Jones, 2009). This can assist with the fact that when there is an announcement about an outbreak people begin to get anxious and use search engines to find out all they can about the outbreak and then quells when the media does not report as strongly about the outbreak (Tausczik, 2016).

In the future, Google Trends, could be useful to act as an early form of surveillance for other infectious diseases. It may highlight how to gauge what people are thinking or searching for on the internet when an outbreak occurs. Data from social media and search engines can help keep the public informed and give public health officials an earlier warning to prepare for an outbreak (Kelly, 2013). While the Centers for Disease Control and Prevention do have a surveillance system for influenza, by the time the information is published it lags by two weeks, and social media can fill the gap and be more up to date (Kelly, 2013). The use of social media for public health surveillance is not new, and was used in 2011 to look at the H1N1 pandemic from 2009 using keywords on Twitter (Kelly, 2013). Computer scientists and researches from the school of medicine at Johns Hopkins University developed a new screening program for tweets that produce live updates on the flu and it filters out chatter that is not directly linked to flu infection (Sneiderman, 2013). With the combined use of search engine queries such as Google Trends and social media, public health surveillance could be able to predict where and when an outbreak will occur (Kelly, 2013).

In the last decade, there have been more articles pertaining to using social media as a form of surveillance because there has been an increase in the output of health-related information that is on the internet (Charles-Smith, 2015). With more articles and research going into this subject, it suggests that there is a growing interest in understanding how social media can play an important role in detecting disease through the use of online surveillance (Charles-Smith, 2015).

Limitations

While Google Trends graphs and the related queries are useful to know when terms were popular, it has one downfall. The related queries could not be determined exactly when one became popular. Another limitation could be the how the names of the disease or terminology was used. People may not be searching for the phrase “vaccine ingredients” and instead be looking for a single ingredient or asking “what ingredients are in the MMR vaccine?”. There needs to be a better understanding of the related search terms, and Google Correlate can be one way to find these terms, but there needs to be more research done using Google Correlate. Therefore, all of the searches surrounding the 2014-2015 measles outbreak may not have been observed. This study only used one system (Google) and no other platforms were used. In the future, Google along with other platforms such as Twitter should be used for a more robust assessment of similar searches across multiple platforms.

Conclusion

This study aimed to have a better understanding of how the online environment can affect vaccine confidence in parents. Future research needs to be focused on ways to develop new or existing ways to monitor outbreaks of vaccine-preventable diseases using these informatics-based methods.

Chapter 4- Conclusion and recommendations

Conclusion

Since the mid 2000s, the public health field has come to recognize that social media can be used as a form of surveillance with monitoring the prevalence of a disease, identifying an outbreak at an early stage and detecting a disease when there is a mass gathering (Conway, 2014). Social media surveillance may assist in improving the ability to detect outbreaks of diseases at a faster rate than traditional surveillance methods and able to heighten the response to the outbreak (Charles-Smith, 2014). Technological advances have shown that there is a possibility to be able to use social media as a tool for monitoring and surveillance (Paul, 2016).

In the beginning social media surveillance was used for tracking influenza (Paul, 2016). Twitter can be used to estimate disease activity, as is in the case for Signorini, the focus was on H1N1. Twitter was faster than traditional systems, which had a lag time of one to two weeks because these type of systems had to rely on outpatient reporting and lab test results (Signorini, 2011 and Schmidt, 2012). Other studies also used Twitter and tracking of the H1N1. Schmidt reported that social media data matched very closely to the Centers for Disease Control and Prevention influenza-like illness surveillance system than actual lab result surveillance. Another study in 2010 came to the conclusion that social media can predict outbreaks of the flu earlier than the traditional surveillance systems (Schmidt, 2012).

Recently, researchers believe that social media surveillance can expand from influenza tracking and move towards other infectious diseases (Paul, 2016). There was a study done on the cholera outbreak after the Haiti earthquake which found that using social media surveillance the outbreak could have been discovered two weeks before officials detected it (Charles-Smith, 2014). This shows that social media surveillance can assist with traditional methods of surveillance, and, at times, even be a better alternative to the traditional ways.

Recommendations

Global pandemics have galvanized interest in improving the early warning surveillance systems (Bernardo, 2013). There is a need to increase and improve the use of disease surveillance data due to how globally connected the world is. Social media has become more pertinent in the field of public health and useful to surveillance for real-time data that is able to detect, monitor and forecast disease trends that give ample warning time to be prepared and have a faster response time (Dodge, 2017). While social media will never replace traditional methods for surveillance, it can be an additional source to provide information (Fung, 2015).

Social media can assist with three functions for public health surveillance: monitoring information, disease detection, and forecasting of disease incidence (Fung, 2015). Social media can monitor information through news feeds. For disease detection, it can provide additional sources of information or data for surveillance to assist public health officials with detecting a disease outbreak (Fung, 2015). This can be done using three models of surveillance. Syndromic, it can detect disease through people using social media accounts. Participatory, when people self-report symptoms. Event-based, being able to detect an unofficial or rumors that flow through social media (Fung, 2015). For forecasting, social media can be used to forecast an incidence of a disease (Fung, 2015). Advantages of social media consist of being able to identify disease trends in real-time (can also support the detection of the outbreak and response), it is open and accessible to the public, it is either low-cost or free to use, and is user friendly (Bernardo, 2013). Social media can track through the use of geolocation, which could lead to medical professionals knowing faster where there is an infectious disease outbreak (Bernardo, 2013). An example of social media use would be when Facebook and UNICEF partnered for project about Zika (Doge, 2017). Information was provided to those who were concerned and lived in areas where there was a high risk of Zika (Dodge, 2017).

There is limited research and knowledge in the scope of how social media can assist disease surveillance and there needs to be more research done in this field. Future studies need to go more in-depth in the nature of analyzing data from social media to make sure the data is valid to be able to predict trends in public health. More research needs to go into how to remove the noise on social media so data can be collected that pertains to an actual public health issue such as an outbreak of an infectious disease.

Public health and policy implications

Social media surveillance could assist by being cost effective to supplement traditional public health surveillance methods (Signorini, 2011). This type of social media surveillance could also provide information on other health issues such as side-effects from prescriptions or vaccines, and potential shortages. This would allow public health officials to see the opinions of the public and craft their messages to quell the public's fear.

In May of 2013, there was an outbreak of measles in the Netherlands primarily around a group of Orthodox Protestants who did not vaccinate for religious reasons. The Mollema study wanted to know if social media hits about the measles compared to the number of new articles and the epidemiologic curve. There were three peaks in the epidemiologic curve as well as three peaks on social media. These peaks occurred when there was an announcement regarding an update to the measles (Mollema, 2014). This study acknowledged the fact that social media, in this case, was more useful as a tool of public opinion than for disease detection (Mollema, 2014). This study exhibits that it depends on the disease because some times social media can act as a disease detector while, other times, it reflects the opinion the public has. While this study did not show that social media was useful for disease surveillance, it gave way to another form in which social media can be an assistant to the field of public health. In this form it may be useful to public health officials because it could let them see what the public thinks related to interventions during and after an outbreak (Mollema, 2014). This form may assist public health officials with how to shape future messages and ways to change what the public is critiquing.

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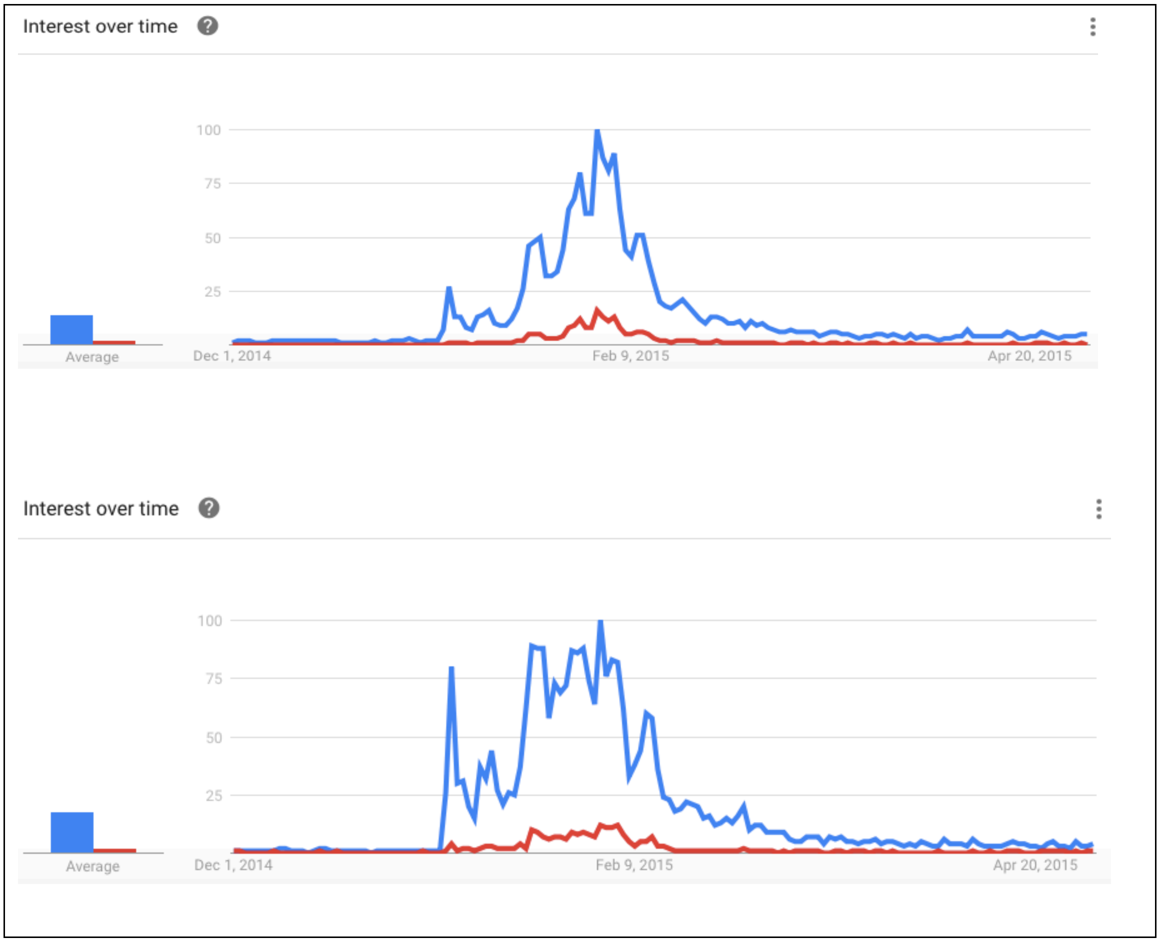
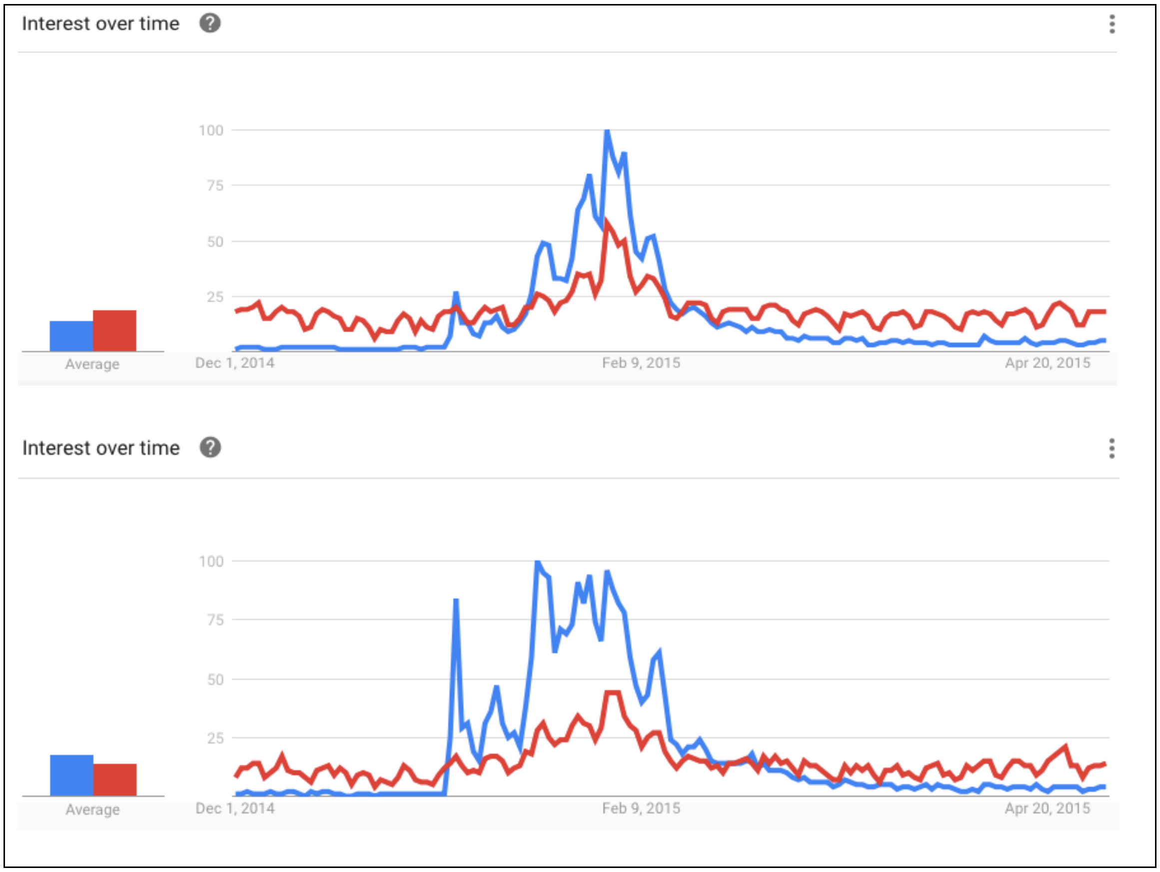
Appendix

List of Graphs and Tables for Chapter 3

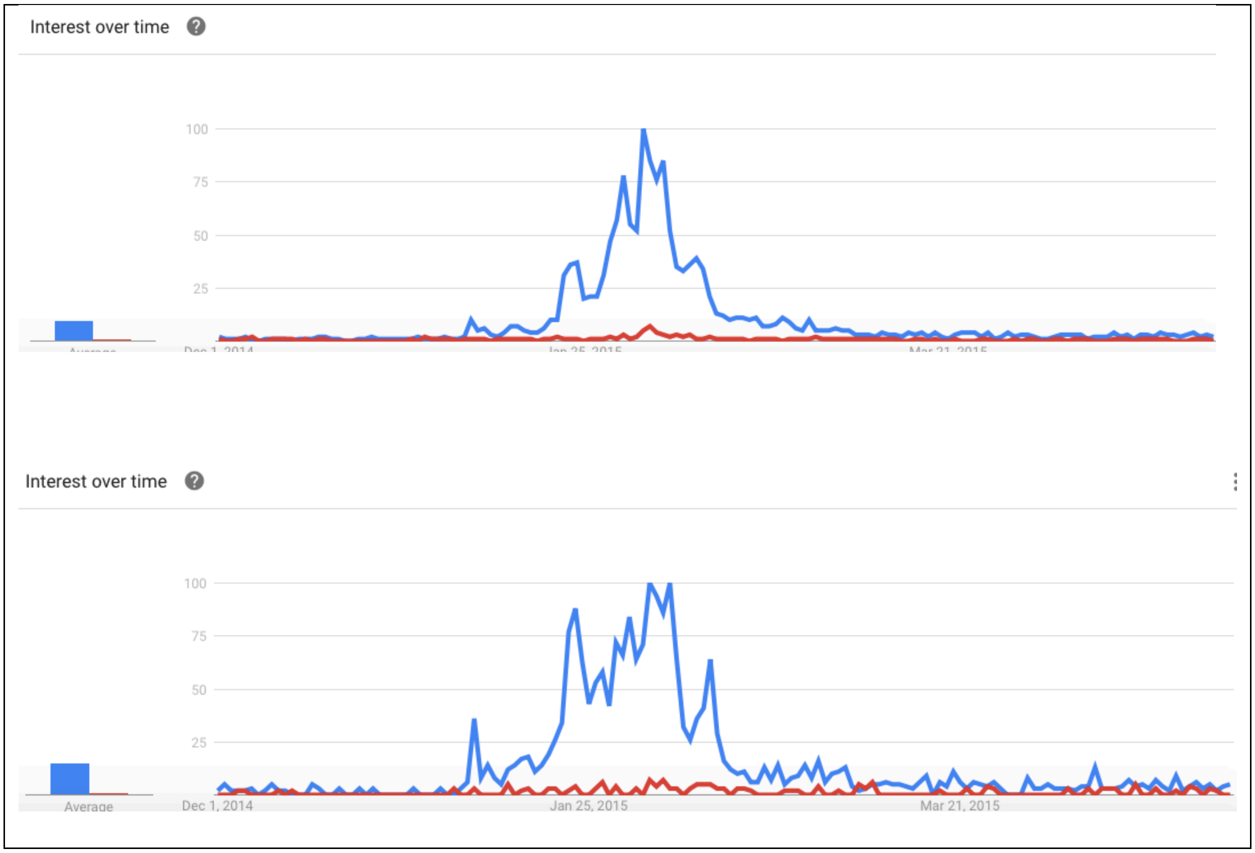
Google Trends Graphs



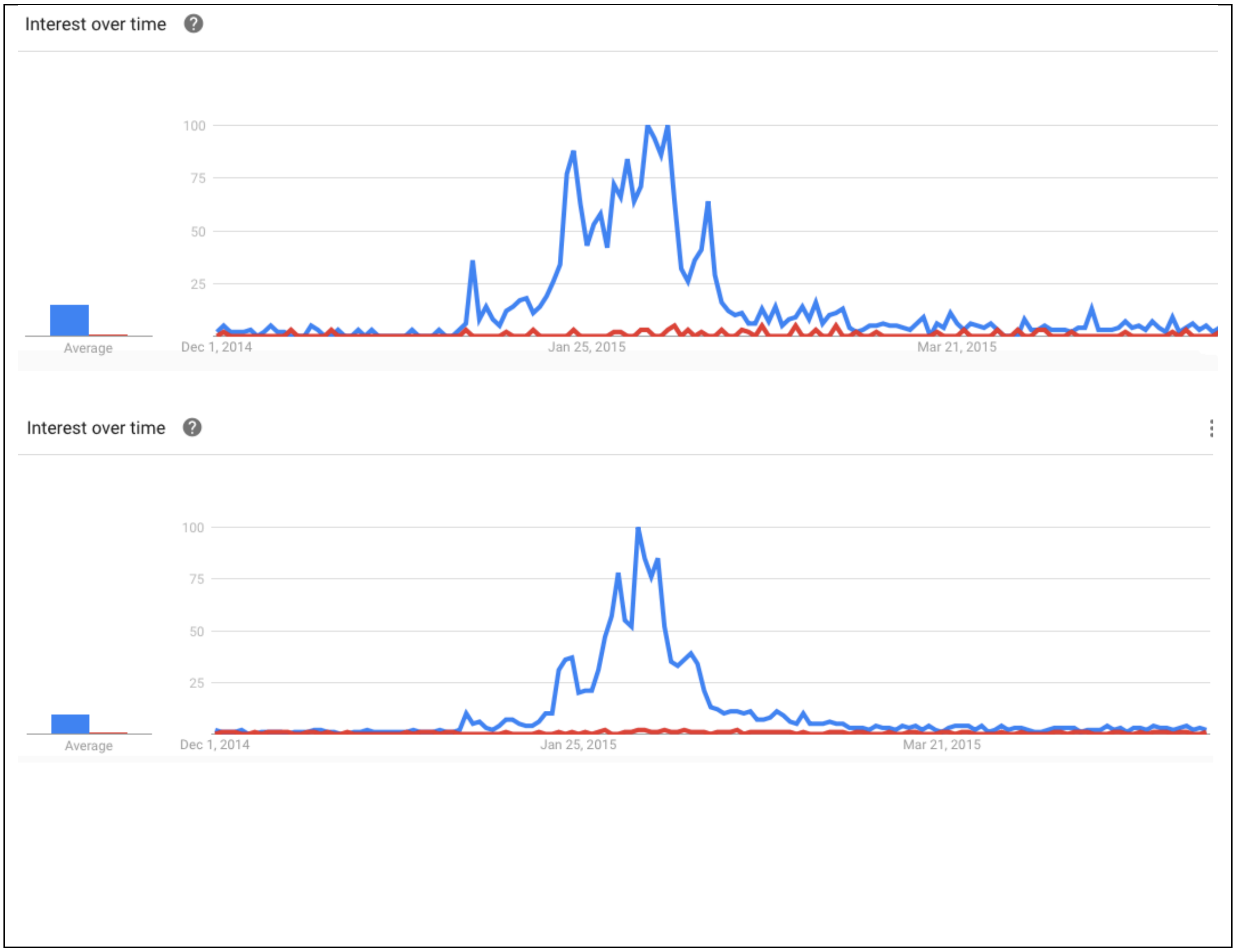
Graph 1. Measles (Blue); Measles vaccine (Red).
Panel A is the United States and Panel B is



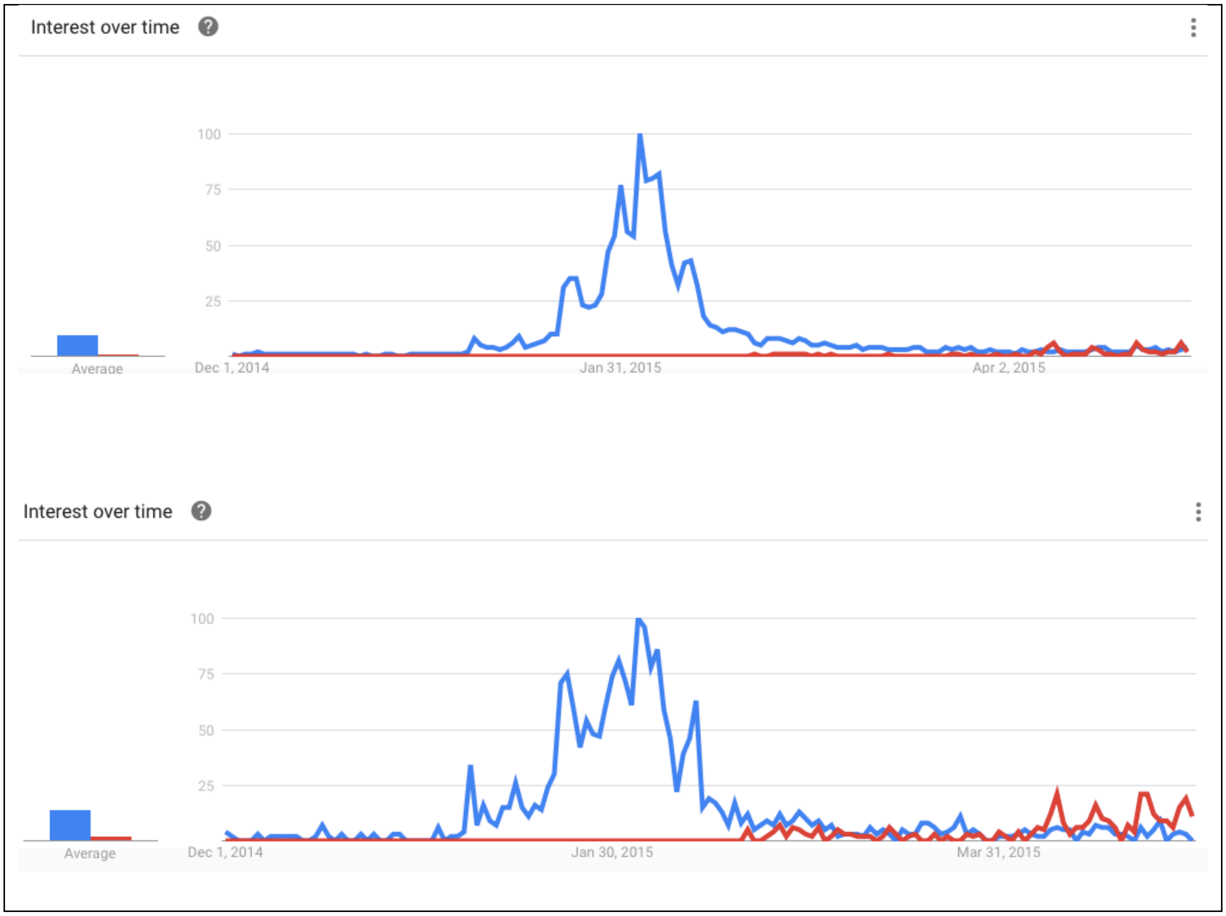
Graph 2. Measles (Blue); Vaccine (Red). Panel A is the United States and Panel B is California



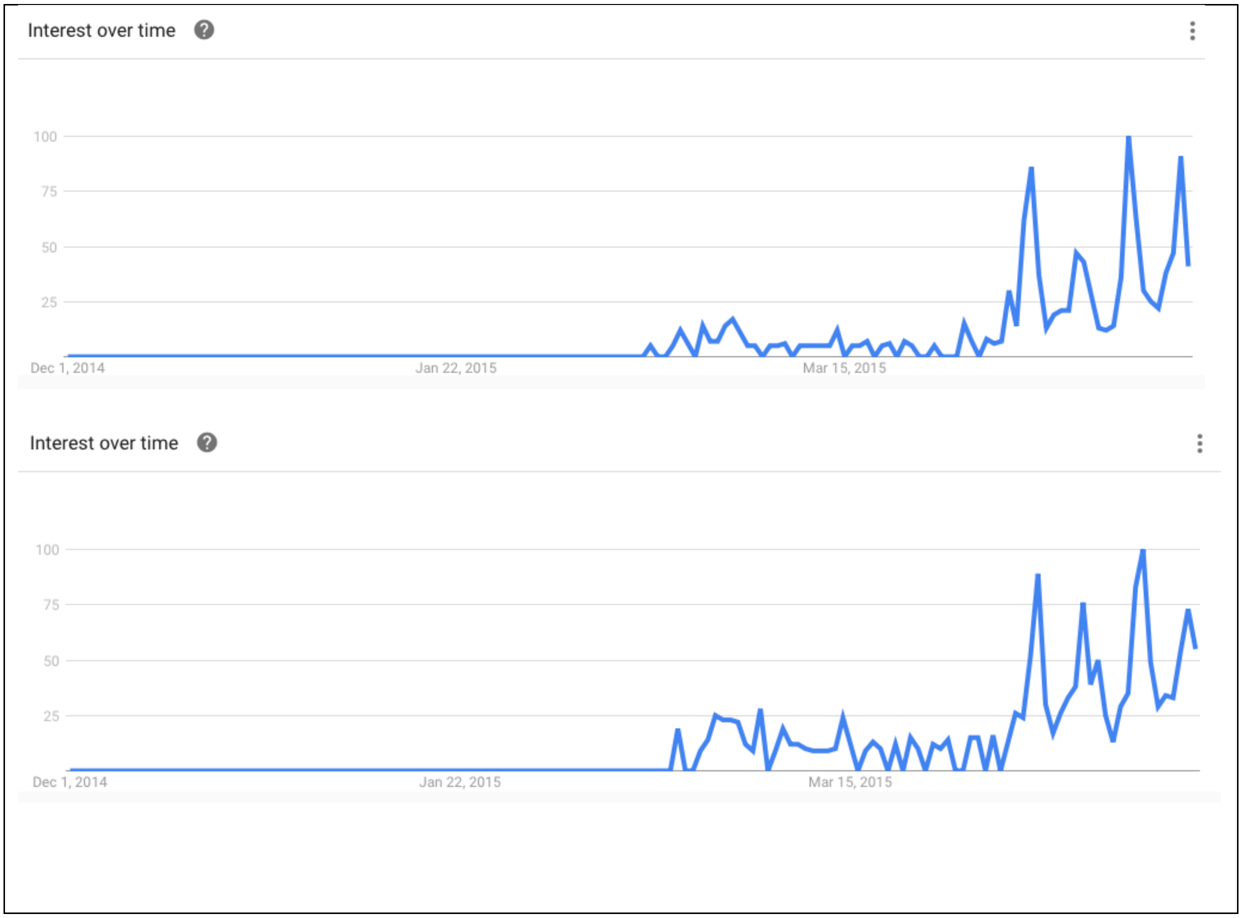
Graph 3. Measles vaccine (Blue); Vaccine ingredients (Red). Panel A is the United States and Panel B is California



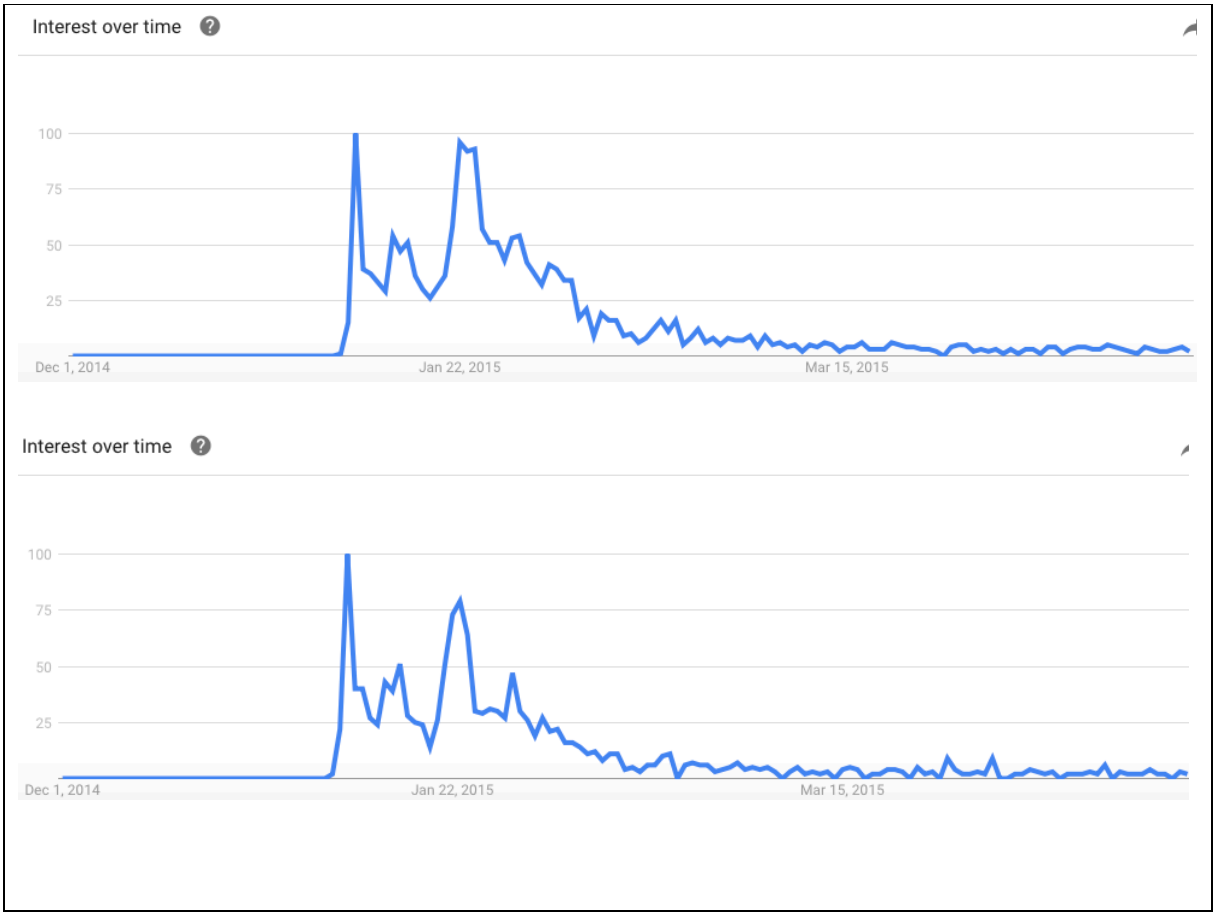
Graph 4. Measles vaccine (Blue); Vaccine safety (Red). Panel A is the United States and Panel B is California



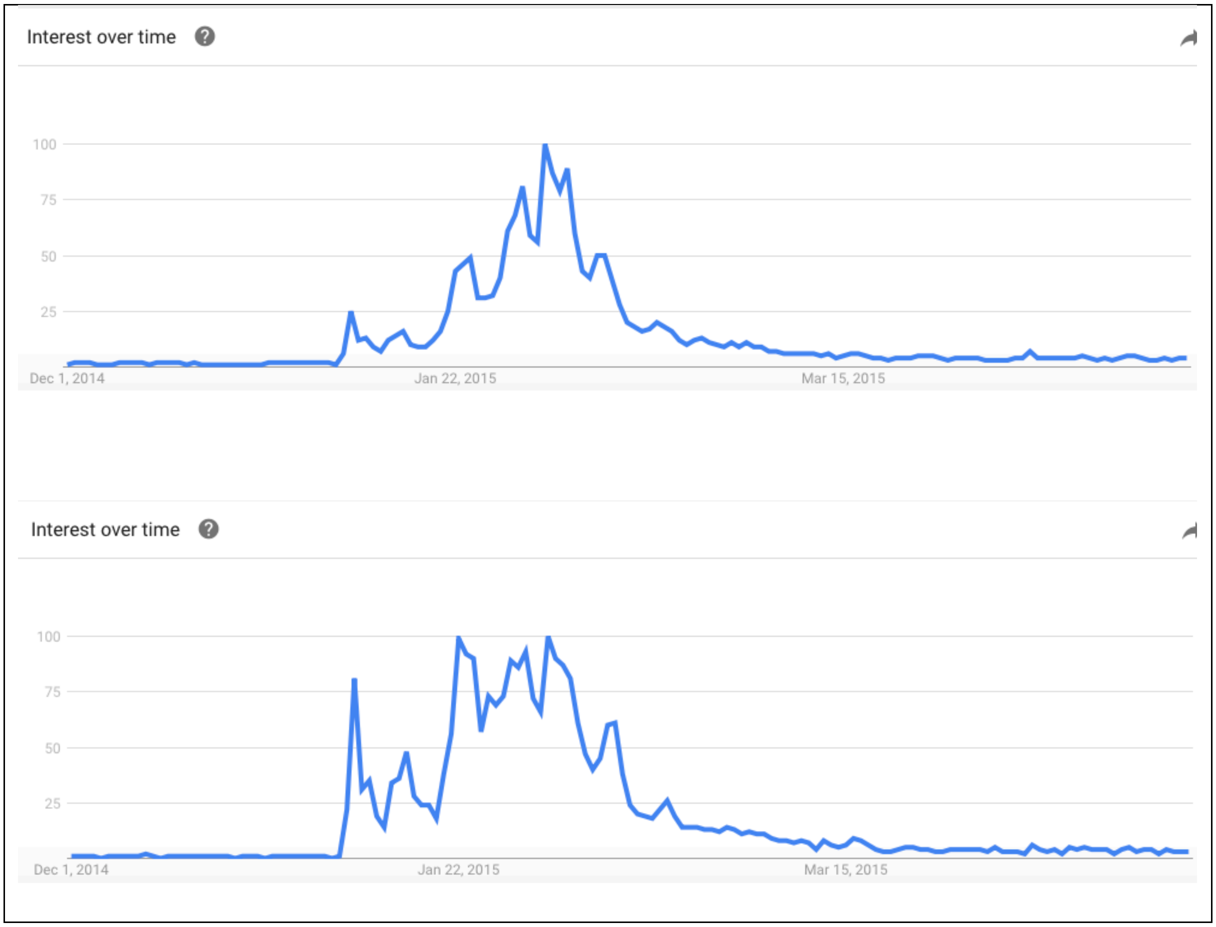
Graph 5. Measles vaccine (Blue); SB 277 (Red). Panel A is the United States and Panel B is California



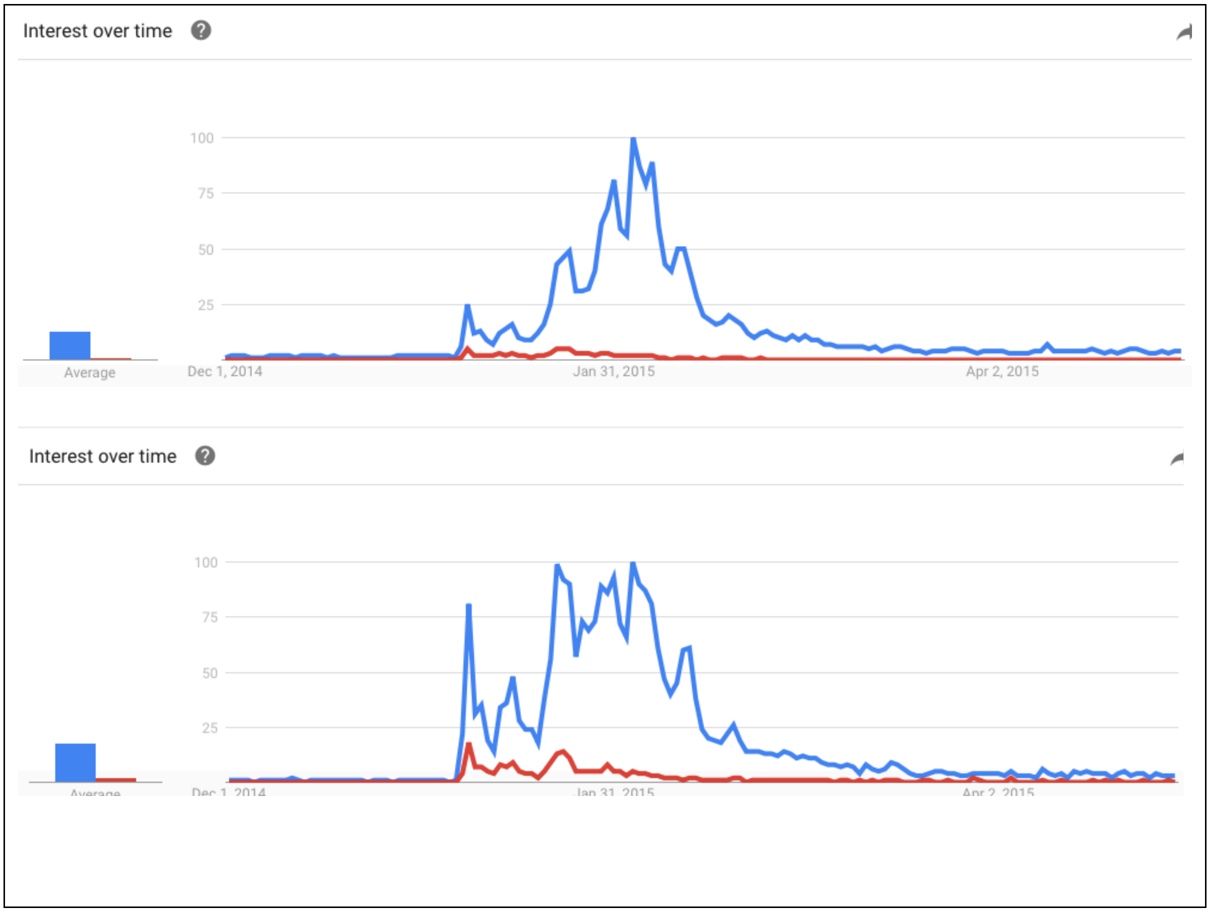
Graph 6. SB 277 (Blue). Panel A is the United States and Panel B is California



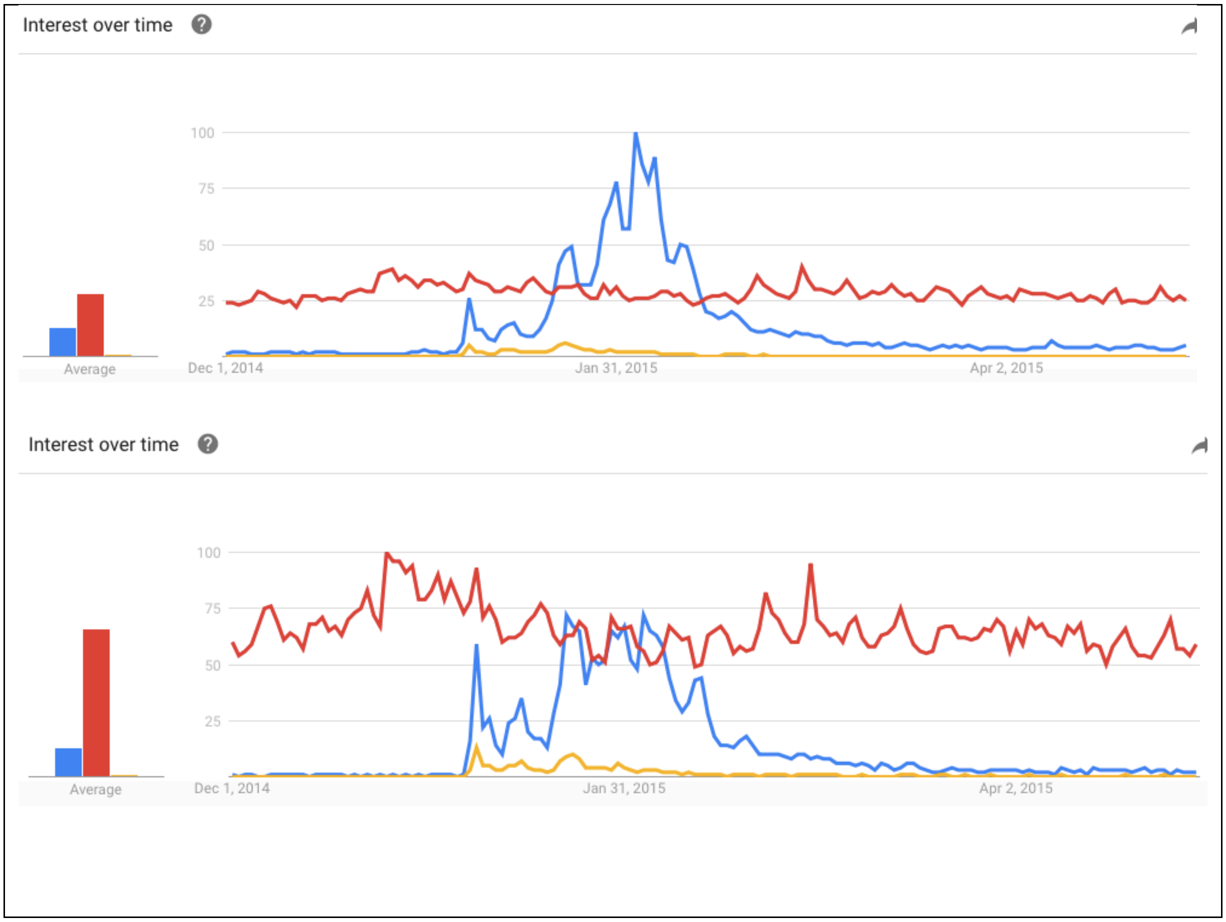
Graph 7. Disneyland measles (Blue). Panel A is the United States and Panel B is California



Graph 8. Measles (Blue). Panel A is the United States and Panel B is California



Graph 9. Measles (Blue); Disneyland measles (Red). Panel A is the United States and Panel B is California



Graph 10. Measles (Blue); Disneyland (Red); Disneyland measles (Yellow). Panel A is the United States and Panel B is California

Google Trends Related Queries Tables

Table 1. Measles; Measles vaccine related search queries for the United States and California							
Measles; Measles vaccine							
United States				California			
Measles		Measles vaccine		Measles		Measles vaccine	
#	Term	#	Term	#	Term	#	Term
1	Disneyland	1	Measles Disneyland	1	Disneyland	1	Measles symptoms
2	Disneyland measles	2	When does child get measles vaccine	2	Disneyland measles outbreak	2	Measles vaccine schedule
3	Measles outbreak Disneyland	3	Should adults get measles vaccine	3	Disney measles	3	Measles vaccine history
4	Measles outbreak 2015	4	When did measles vaccine start in US	4	Measles at Disneyland	4	When do babies get measles vaccine
5	Measles in Disneyland	5	How long is the measles vaccine good for	5	Measles in Disneyland	5	

6	Measles outbreak Disney	6	When did the measles vaccine become available	6	Is measles deadly	6	
7	Measles at Disneyland	7	When was measles vaccine introduced in US	7	Measles death rate	7	
8	Disney world measles	8	When can baby get measles vaccine	8	Measles party	8	
9	Measles outbreak in Disneyland	9	At what age do you get measles vaccine	9	Can you get measles if you are vaccinated	9	
10	Measles outbreak spreads	10	Deaths from measles vaccine	10	Can you get measles twice	10	
11	Palatine measles	11	Measles vaccine effectiveness	11	Measles outbreak spreads California	11	
12	Measles at Disney world	12	Measles vaccine for adults	12	Can you get measles more	12	

					than once		
13	Measles bart	13	What age do you get measles vaccine	13	Measles at Disney world	13	
14	Measles parties	14	How long does measles vaccine last	14	Sign and symptoms of measles	14	
15	Measles in Chicago	15	Age for measles vaccine	15	Measles Disneyland	15	
16	Current events	16	When was the measles vaccine introduced	16	Measles news	16	
17	Measles in Michigan	17	Measles vaccine age	17	Measles shot	17	
18	Arizona measles outbreak	18	How long does the measles vaccine last	18	Symptoms of measles	18	
19	Measles outbreak spreads California	19	Measles vaccine booster	19	Measles outbreak	19	
20	Can you get the measles twice	20	How long is measles vaccine good for	20	California measles	20	

Table 2. Measles; Vaccine related search queries for the United States and California							
Measles; Vaccine							
United States				California			
Measles		Vaccine		Measles		Vaccine	
#	Term	#	Term	#	Term	#	Term
1	Disneyland	1	Jimmy Kimmel vaccine	1	Disneyland	1	Measles symptoms
2	Disneyland measles	2	How long does the measles vaccine last	2	Disneyland measles outbreak	2	How long does measles vaccine last
3	Measles outbreak Disneyland	3	When do babies get measles vaccine	3	Disney measles	3	Jimmy Kimmel vaccine
4	Measles outbreak 2015	4	California vaccine bill	4	Measles at Disneyland	4	California vaccine bill
5	Measles in Disneyland	5	When was the measles vaccine introduced	5	Measles in Disneyland	5	Penn and Teller vaccine argument
6	Measles outbreak Disney	6	Chris Christie vaccine	6	Is measles deadly	6	Measle vaccine

7	Measles at Disneyland	7	When does child get measles vaccine	7	Measles death rate	7	Measles
8	Disney world measles	8	When did measles vaccine start in US	8	Measles party	8	Measles vaccine
9	Measles outbreak in Disneyland	9	Jimmy Kimmel anti vaccine	9	Can you get measles if you are vaccinated	9	Measles outbreak
10	Measles outbreak spreads	10	When was measles vaccine introduced in US	10	Can you get measles twice	10	Anti vaccine movement
11	Palatine measles	11	Measles vaccine age	11	Measles outbreak spreads California	11	MMR vaccine schedule
12	Measles at Disney world	12	Measles vaccine for adults	12	Can you get measles more than once	12	MMR vaccine
13	Measles bart	13	Measles outbreak	13	Measles at Disne	13	Anti vaccine

					y world		
14	Measles parties	14	Jenny McCarthy vaccine flip flop	14	Sign and sympt oms of measl es	14	MMR vaccin e side effects
15	Measles in Chicago	15	Penn and Teller vaccine argument	15	Measl es Disne yland	15	Vacci nes
16	Current events	16	Measle vaccine	16	Measl es news	16	Typho id vaccin e
17	Measles in Michigan	17	How long does measles vaccine last	17	Measl es shot	17	Natio nal vaccin e inform ation center
18	Arizona measles outbreak	18	Measles vaccine effectiveness	18	Symp toms of measl es	18	Garda sil vaccin e
19	Measles outbreak spreads Californi a	19	Measles vaccine history	19	Measl es outbre ak	19	
20	Measles booster shot adults	20	Measles symptoms	20	Califo rnia measl es	20	

Table 3. Measles vaccine; Vaccine ingredients search related queries for the United States and California							
Measles vaccine; Vaccine ingredients							
United States				California			
Measles vaccine		Vaccine ingredients		Measles vaccine		Vaccine ingredients	
#	Term	#	Term	#	Term	#	Term
1	Disneyland measles	1	MMR vaccine ingredients	1	Measles outbreak	1	
2	Should adults get measles vaccine	2	MMR vaccine	2	Measles symptoms	2	
3	When was measles vaccine introduced in US	3		3	How long does measles vaccine last	3	
4	When can baby get measles vaccine	4		4	Measles vaccine schedule	4	
5	At what age do you get measles vaccine	5		5	Measles vaccine history	5	

6	Deaths from measles vaccine	6		6	When do babies get measles vaccine	6	
7	When was the measles vaccine introduced	7		7		7	
8	How long does measles vaccine last	8		8		8	
9	Age for measles vaccine	9		9		9	
10	Measles vaccine history	10		10		10	
11	Measles vaccine for adults	11		11		11	
12	What age do you get measles vaccine	12		12		12	
13	Measles vaccine effectiveness	13		13		13	

14	Measles vaccine age	14		14		14	
15	How long does the measles vaccine last	15		15		15	
16	Measles vaccine booster	16		16		16	
17	Measles outbreak	17		17		17	
18	When do babies get measles vaccine	18		18		18	
19	CDC measles vaccine	19		19		19	
20	CDC measles	20		20		20	

Table 4. Measles vaccine; Vaccine safety search related queries for the United States and California

Measles vaccine; Vaccine safety							
United States				California			
Measles vaccine		Vaccine safety		Measles vaccine		Vaccine safety	
#	Term	#	Term	#	Term	#	Term
1	Disneyland measles	1		1	Measles symptoms	1	
2	Deaths from measles vaccine	2		2		2	
3	When was the measles vaccine introduced	3		3		3	
4	Should adults get measles vaccine	4		4		4	
5	Where to get measles vaccine	5		5		5	
6	When was measles vaccine introduced in US	6		6		6	
7	What age do babies get	7		7		7	

	measles vaccine						
8	At what age do you get measles vaccine	8		8		8	
9	When can baby get measles vaccine	9		9		9	
10	How long does the measles vaccine last	10		10		10	
11	How long does measles vaccine last	11		11		11	
12	When do babies get measles vaccine	12		12		12	
13	Age for measles vaccine	13		13		13	
14	Measles vaccine booster	14		14		14	
15	Measles vaccine history	15		15		15	
16	Measles vaccine age	16		16		16	

17	Measles vaccine effectiveness	17		17		17	
18	Measles outbreak	18		18		18	
19	What age do you get measles vaccine	19		19		19	
20	Measles vaccine for adults	20		20		20	

Table 5. Measles vaccine; SB277 search related queries for the United States and California							
Measles vaccine; SB277							
United States				California			
Measles vaccine		SB277		Measles vaccine		SB277	
#	Term	#	Term	#	Term	#	Term
1	Disneyland measles	1	Sb277 California	1	Measles symptoms	1	Sb277 California
2	Disneyland measles outbreak	2		2	Measles vaccine history	2	
3	When did measles vaccine start in US	3		3		3	
4	When did the measles vaccine became available	4		4		4	
5	Measles deaths before vaccine	5		5		5	
6	When was measles vaccine introduced in US	6		6		6	

7	Who should get measles vaccine	7		7		7	
8	How effective is the measles vaccine	8		8		8	
9	Measles vaccine shedding	9		9		9	
10	What age do you get the measles vaccine	10		10		10	
11	Does measles vaccine wear off	11		11		11	
12	When does baby get measles vaccine	12		12		12	
13	When can baby get measles vaccine	13		13		13	
14	How old do you have to be to get the measles vaccine	14		14		14	
15	Deaths from measles vaccine	15		15		15	
16	What age measles vaccine	16		16		16	

17	Measles vaccine deaths	17		17		17	
18	How long is measles vaccine good for	18		18		18	
19	Measles vaccine age	19		19		19	
20	What age do you get measles vaccine	20		20		20	

Table 6. SB277 search related queries for the United States and California				
Term	SB277			
Place	United States	SB277	California	SB277
	#	Term	#	Term
	1	Sb277 California	1	Sb277 California

Google Correlate Tables

Table 7. Google Correlate for measles between December 2014 and April 2015

Word	Measles			
Time Frame	W/O excluding the word measles		W/excluding the word measles	
	Correlate	Term	Correlate	Term
Dec '14- Apr '15	0.9994	Measle	0.9994	Measle
	0.9979	Measles in adults	0.9973	Sarampión
	0.9972	Sarampión	0.9960	MMR schedule
	0.9959	Measles immunization	0.9959	MMR booster
	0.9958	MMR booster	0.9926	Sarampion
	0.9954	Measles after vaccination	0.9916	MMR vaccination
	0.9954	Measles shots	0.9916	MMR shots
	0.9954	What are the symptoms of measles	0.9910	MMR
	0.9953	Measles shot	0.9907	MMR shot
	0.9952	The measles virus	0.9888	MMR vaccination schedule
	0.9948	MMR schedule	0.9888	Blank February calendar
	0.9947	Measles symptoms	0.9886	Vaccine schedule
	0.9945	The measles	0.9886	MMR vaccine schedule
	0.9945	What is the measles	0.9883	Measle vaccine
	0.9939	Measles vaccination	0.9880	El Sarampion
	0.9937	Measles outbreak	0.9875	MMR vaccine

	0.9931	Cure for measles	0.9869	Measle symptoms
	0.9927	Sarampion	0.9865	Vaccine booster
	0.9926	Measles vaccinations	0.9860	MMR vaccine age
	0.9925	Measles booster	0.9858	The MMR vaccine

Table 8. Google Correlate for vaccine between December 2014 and April 2015

Word	Vaccine			
Time Frame	W/O excluding the word vaccine		W/excluding the word vaccine	
	Correlate	Term	Correlate	Term
Dec '14- Apr '15	0.9862	Childhood vaccine	0.9832	Immunized
	0.9832	Immunized	0.9831	Rubella
	0.9831	Rubella	0.9830	Vaccinations and autism
	0.9830	Vaccinations and autism	0.9819	Death rate US
	0.9824	The vaccine	0.9807	What is rubella
	0.9819	Death rate US	0.9805	Vaccinated
	0.9810	Vaccine ingredients	0.9797	Cause of measles
	0.9810	MMR vaccine	0.9794	Measles outbreaks
	0.9809	CDC vaccine	0.9793	Herd immunity
	0.9807	What is rubella	0.9781	School vaccination requirements
	0.9805	MMR vaccines	0.9778	Measles epidemic
	0.9805	Vaccinated	0.9778	Algebraic manipulation
	0.9797	Cause of measles	0.9767	Measles mortality rate
	0.9794	Measles outbreaks	0.9766	Measles mortality
	0.9793	Herd immunity	0.9766	Measles statistics
	0.9790	The MMR vaccine	0.9763	MMR shot
	0.9781	School vaccination requirements	0.9760	Get vaccinated
	0.9780	Measles vaccines	0.9760	How thick is a nickel
	0.9778	Measles epidemic	0.9760	MMR
	0.9778	Algebraic manipulation	0.9759	Measles death rate

Table 9. Google Correlate for measles vaccine between December 2014 and April 2015

Word	Measles vaccine			
Time Frame	W/O excluding the phrase measles vaccine		W/excluding the phrase measles vaccine	
	Correlate	Term	Correlate	Term
Dec '14- Apr '15	0.9990	Measle vaccine	0.9990	Measle vaccine
	0.9984	The measles	0.9984	The measles
	0.9981	Measles vaccination	0.9981	Measles vaccination
	0.9974	Vaccine for measles	0.9974	Vaccine for measles
	0.9971	The MMR vaccine	0.9971	The MMR vaccine
	0.9970	Measles vaccinations	0.9970	Measles vaccinations
	0.9969	German measles	0.9969	German measles
	0.9962	Vaccine history	0.9962	Vaccine history
	0.9961	Measles shot	0.9961	Measles shot
	0.9960	Des fleur	0.9960	Des fleur
	0.9956	MMR vaccine	0.9956	MMR vaccine
	0.9955	Maison de	0.9955	Maison de
	0.9954	Effects of measles	0.9954	Effects of measles
	0.9948	Measles vaccine side effects	0.9947	MMR vaccination
	0.9947	MMR vaccination	0.9946	What is rubella
	0.9946	What is rubella	0.9946	MMR shot
	0.9946	MMR shot	0.9946	Maison de fleur
	0.9946	Maison de fleur	0.9941	Vaccinated
	0.9941	Vaccinated	0.9940	3 day measles
	0.9940	3 day measles	0.9940	Measles complications

Table 10. Google Correlate for vaccine ingredients between December 2014 and April 2015

Word	Vaccine Ingredients			
Time Frame	W/O excluding the phrase vaccine ingredients		W/excluding the phrase vaccine ingredients	
	Correlate	Term	Correlate	Term
Dec '14- Apr '15	0.9925	Vaccination and autism	0.9925	Vaccination and autism
	0.9919	Vaccine studies	0.9919	Vaccine studies
	0.9898	Vaccine shedding	0.9898	Vaccine shedding
	0.9892	Vaers	0.9892	Vaers
	0.9878	Measles deaths	0.9878	Measles deaths
	0.9877	Measles in US	0.9877	Measles in US
	0.9870	Vaccines and autism	0.9870	Vaccines and autism
	0.9844	Vaccinated vs unvaccinated	0.9844	Vaccinated vs unvaccinated
	0.9844	Deaths from vaccines	0.9844	Deaths from vaccines
	0.9838	Dangers of vaccines	0.9838	Dangers of vaccines
	0.9836	Deaths from measles	0.9836	Deaths from measles
	0.9835	What is in vaccines	0.9835	What is in vaccines
	0.9830	Measles statistics	0.9830	Measles statistics
	0.9824	Vaccine death	0.9824	Vaccine death
	0.9822	Childhood vaccine	0.9822	Childhood vaccine
	0.9821	CDC vaccine ingredients	0.9820	Truth about vaccines
	0.9820	Truth about vaccines	0.9819	Measles in the US
	0.9819	Measles in the US	0.9816	Do vaccines cause autism
	0.9816	Do vaccines cause autism	0.9815	Vaccine truth
	0.9815	Vaccine truth	0.9813	Vaccinate

Table 11. Google Correlate for vaccine safety between December 2014 and April 2015

Word	Vaccine Safety			
Time Frame	W/O excluding the phrase vaccine safety		W/excluding the phrase vaccine safety	
	Correlate	Term	Correlate	Term
Dec ’14-Apr ‘15	0.9866	Vaccines	0.9866	Vaccines
	0.9822	Vaccine controversy	0.9822	Vaccine controversy
	0.9814	Vaccinations	0.9814	Vaccinations
	0.9804	Injury compensation	0.9804	Injury compensation
	0.9790	Pro vaccine	0.9790	Pro vaccine
	0.9763	Vaccines cause autism	0.9763	Vaccines cause autism
	0.9761	Vaccine injury	0.9761	Vaccine injury
	0.9760	Are vaccines safe	0.9760	Are vaccines safe
	0.9755	Cause autism	0.9755	Cause autism
	0.9753	Compensation program	0.9753	Compensation program
	0.9743	Fetal cells in vaccines	0.9743	Fetal cells in vaccines
	0.9743	Vaccinate your child	0.9743	Vaccinate your child
	0.9739	Fetal tissue	0.9739	Fetal tissue
	0.9737	MRC-5	0.9737	MRC-5
	0.9732	Vaccine debate	0.9732	Vaccine debate
	0.9723	Why vaccinate	0.9723	Why vaccinate
	0.9714	Vaccination	0.9714	Vaccination
	0.9714	Vaccine exemption	0.9714	Vaccine exemption
	0.9707	Vaccine injury compensation	0.9707	Vaccine injury compensation
	0.9706	Ingredients in vaccines	0.9706	Ingredients in vaccines

Table of Terms

Table 12. Definitions and examples of parents who are vaccine confidence, vaccine hesitance and vaccine refusal

Term	Definition	Types of Parents
Vaccine Confidence	"Influenced by three components: confidence, complacency and convenience." "Parents have trust in: the recommended immunizations, with the provider who is administering the vaccine, as well as those who license the vaccines and those who review the recommended vaccine schedule."	-Parents who are pro-vaccine and vaccinate their children without questioning -Parents who vaccinate their children but have questions but vaccinate because it is the norm.
Vaccine Hesitance	"Refers to delay or refusal of vaccination despite availability of vaccination services." "Has a much wider net than vaccine confidence."	-Parents who question the doctor but vaccinate their children -Parents who seek out all health and vaccine information -Parents who delay vaccination -Parents who are worried about adverse vaccine reactions
Vaccine Refusal	"Refers to a certain perception on the susceptibility and severity of disease, lack of trust in safety and effectiveness of vaccines as well as mistrust in those who work in the medical field and the government"	-Parents believe in adverse reactions are underreported, vaccines can lead to idiopathic illnesses, vaccines only provide temporary immunity, drug companies profits are selling vaccines, vaccination for school entry is a violation of civil liberties and diseases that vaccines prevent are already on the decline. -Parents also believe that the vaccine can cause the illness, they are ineffective and part of a conspiracy and that too many vaccines at once can harm a child's immune system.

IRB Letter

EMORY UNIVERSITY | Institutional Review Board

July 26, 2016

Paula Frew, PhD MA MPH
School of Medicine
Infectious Diseases

RE: Determination: No IRB Review Required
eIRB#: IRB00090542
Title: ***Transforming Vaccine Hesitancy into Confidence: Research to Address Parents' Vaccine Decision-Making and Inform Development of Novel Immunization Communication/ Education Strategies***
PI: Frew

Dear Dr. Frew:

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition of "research" with human subjects or "clinical investigation" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will collaborate with the National Vaccine Program Office under Goal 3 of the National Vaccine Plan. This project was designed to improve the health of Americans by better understanding the decision-making processes surrounding vaccines and vaccine programs. The goal is to improve current and future vaccine/immunization programs using data collected under this project.

Please note that this determination does not mean that you cannot publish the results. This determination could be affected by substantive changes in the study design, subject populations, or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Sincerely,

Sam Roberts, CIP
Research Protocol Analyst, Sr.

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Ver. 1/17/2014