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Vaccination Situation: a History of Vaccine Refusal in the United States and Vaccine Beliefs at the University of Mississippi

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VACCINATION SITUATION: A HISTORY OF VACCINE REFUSAL IN THE UNITED STATES AND VACCINE BELIEFS AT THE UNIVERSITY OF MISSISSIPPI

By
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ABSTRACT
AUSTIN THOMAS VITALE: Vaccination Situation: a History of Vaccine Refusal in the United States and Vaccine Beliefs at the University of Mississippi
(Under the direction of Melissa Bass)

The goals of this research were to trace a narrative of vaccine refusal in the United States from the nation's inception to the present day and identify any impact or influence from refusal ideology on vaccine beliefs of University of Mississippi undergraduates. A review of historical literature regarding vaccine refusal in the United States developed a historical narrative, and a quantitative survey was utilized to identify the vaccine beliefs of a University of Mississippi sample. Three distinct eras of vaccine refusal were detailed, with the third (present) era distinguished by the use of the internet to spread anti-vaccine ideologies. The survey consisted of two parts: a series of yes/no questions to determine views on vaccine issues and 15 vaccine related statements on a Likert scale. These questions were based WHO recommendations. The survey was developed using Qualtrics and distributed to a University Mississippi sample of 5,000 students stratified for gender, ethnicity, and classification via email. The 315 valid responses were analyzed using descriptive statistics and chi-squared tests. No correlation was found between demographic information and responses, students indicated mostly pro-vaccine beliefs, and vaccine beliefs appeared to occur in groups indicative of broad, ideologies instead of issues-based responses. The University of Mississippi student sample was more pro-vaccine than national samples and appeared resistant to sources of vaccine information besides their health care providers. Understanding these results provide opportunities to improve vaccine education nationally and in Mississippi.

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Chapter I

Introduction

Introduction to Vaccine Refusal

When parents take their children on a trip to Disneyland, they expect to bring back memories of the fun-filled shows, rides, and sights that make up the storied amusement park. Unfortunately for several families who visited the park in late December 2014, they brought back something much different: measles (Foxhall). With more than 100 people in 7 states and Mexico sickened in an ongoing outbreak that can be traced back to a single park visitor infected with the virus, public health officials have begun to worry about the implications of such a widespread up-rise in cases of a vaccine-preventable disease (Xia). Dr. David Kimberlin, a leading pediatric infectious disease specialist, has called the outbreak an "inevitable" consequence of an increased number of unvaccinated Americans that is likely just the beginning:

> "When community protection against measles is weakened because not enough people have been immunized against it, and then you get them together in a central location where they can be exposed to cases imported by travelers from other parts of the world, it's like throwing matches on dry leaves…once measles has gained such a foothold, it spreads extremely easily, and so I anticipate that, unfortunately, we will be seeing a whole lot more cases" (Yurkanin)

Keeping this in mind, it is important to determine why vaccination is important, what is causing so many individuals to remain unvaccinated, and what the current and future effects of vaccine refusal can and will be.

Background

Vaccination—the introduction of an antigen into a body in order to produce immunity against a certain disease—is a technology that can be traced in some form to roughly the 16th century. However, scientific inquiry and rigorous experimentation to find the source of this immunity began at the end of the 18th century. It was at this time that English physician Edward Jenner developed the first reliable vaccination against smallpox by injecting patients with the pus extracted from blisters caused by cowpox. Though some patients developed full immunity to smallpox while others still came down with mild cases, his treatment provided protection against a disease that historically sickened about two thirds of England's population and killed a quarter of it.

In the century that followed, a number of physicians dedicated their lives to determining the exact mechanism that protected the multitudes that received Jenner's smallpox vaccination. However, they had little success until the end of the 19th century. It was then that several scientists, guided by evidence of the influence of microorganisms and non-living pathogens on disease, discovered the first method of creating weakened forms of diseases in a lab instead of finding naturally occurring weakened forms. It was through this discovery that scientists began to develop vaccines for infectious diseases caused by both bacteria and viruses.

The 20th century opened with a stream of new vaccines being introduced to prevent a large number of deadly illnesses. Vaccines for diseases like diphtheria and tetanus saw these diseases practically wiped out from developed societies. However, the side effects caused by these vaccines from still-living bacteria and weakened viruses, including infection with the disease the vaccine was intended to prevent and death, made these early vaccines far from ideal: many individuals were sickened to prevent mass outbreaks and rampant death. Finally, the first vaccines using dead bacteria were developed in the mid-20th century for cholera and typhoid fever. After this, vaccines using inactivated viruses began to prevent diseases like measles, rubella, and pertussis, and notably eradicated diseases like polio from developed countries with very low rates of side effects. Now vaccines are able to prevent most major viral illnesses with nearly no side effects and can be quickly developed to prevent rapidly changing viruses like the flu or novel viruses formed by evolution (Artenstein).

Currently, vaccines for a wide spectrum of viruses and bacteria are given to young children by their health care providers during regular checkups. This has been very successful in preventing outbreaks of viral and bacterial infections due to a concept known as herd protection (**See Figure 1.1**) (Paul). With nearly all of the American population being vaccinated through these routine doctor visits (Centers for Disease Control, 2010), the population as a whole is provided immunity because there are not enough unvaccinated individuals for an infection to take hold and turn into an epidemic. This prevents viruses and bacteria from infecting those few who cannot receive vaccinations due to health problems or who have deep-rooted religious objections. While this protects the small minority of individuals who have legitimate reasons to refuse a

vaccination, it is not recognized by medical professionals as a valid replacement for a vaccination: for heard protection to be sustained, at least 80% -95% of the population needs to be vaccinated, depending on the virus or bacteria in question (Fine). Herd protection has a further benefit—when a virus or bacteria is prevented from being passed between many individuals over a period of time, it also lacks the opportunity to evolve into a vaccine-resistant strain. Preventing the development of these resistant strains is vitally important, since these strains pose a massive risk to the collective health of America—their vaccine resistance allows them to rapidly spread to every corner of the country and infect entire populations with deadly diseases.

In the United States, there are currently no national statutes mandating vaccination against common and deadly infectious disease. The task has been left up to state governments, each of which has a vaccine schedule that is tied to enrollment in public (and in some cases, private) schools. If parents cannot provide proof of the child's vaccination or obtain a permissible exemption, the child cannot enroll.

Within the state governments, state health departments make the final decision on what vaccinations are included in their vaccine schedules, and those are required for public school enrollment. Four exemptions from a state mandated vafccination schedule exist (**See Figure 1.2**):

1. A child may be exempted if he or she has a medical condition, like a compromised immune system, that makes receiving a vaccination unsafe. Such exemptions exist for all vaccinations in every state.

2. A child may be exempted if he or she already has immunity from a disease. This must be proven by a blood test and can be used for all vaccinations in any state.
3. A child may be exempted if his or her family has deep rooted religious beliefs that forbid vaccination, such as Christian Science. This exemption can only be used for exemption from the entire vaccine schedule and is not allowed in Mississippi or West Virginia. Recently passed legislation in California will prohibit this exemption beginning July 1st, 2016.
4. A child may be exempted if his or her family has deep rooted philosophical or ideological objections to vaccination. Just like a religious objection, this can only be used to be exempted from an entire vaccine schedule. This exemption is allowed in 17 states: Arizona, Arkansas, California, Colorado, Idaho, Louisiana, Maine, Michigan, Minnesota, North Dakota, Ohio, Oklahoma, Texas, Utah, Vermont, Washington, and Wisconsin. Recently passed legislation in California and Vermont will prohibit this exemption beginning July 1st, 2016.

With an increased number of parents taking advantage of objections due to concerns that vaccines can cause deadly side effects or developmental disorders, more children lack immunity to diseases such as diphtheria, tetanus, pertussis, measles, mumps, and rubella (National Committee for Quality Assurance). While state policies have traditionally led to sufficient immunity to prevent outbreaks of vaccine-preventable diseases, a sustained rise in the number of parents claiming objections has begun to have startling effects (Nagourney). These parents' choices have caused at least 157,326

hospitalizations and 170 deaths from those diseases between 2000 and 2009 (Madsen; Centers for Disease Control and Prevention, 2011). These are illnesses and deaths that could have been prevented by a vaccination. These disease outbreaks have luckily not been as deadly or virulent as they could be, but they still have terrible consequences such as weakening of herd immunity, costly quarantines to prevent further spread of viruses and bacteria, expensive drugs to treat symptoms, and lost productivity (Roehr; Szucs; Takahashi).

This Study

The purpose of this study is to identify the history of vaccine refusal in the United States and any effects this history has had on contemporary decision-making beliefs of University of Mississippi students. In order to do so, a review of historical literature focusing on vaccine refusal in the United States has been combined with a survey measuring the vaccine beliefs of 315 University of Mississippi undergraduate students. As communities across the country have struggled with outbreaks of diseases that can be prevented with vaccination, it has become apparent that the subject is not only one of critical importance to the nation's health care system, public health system, and collective well-being, but also one that has the ability to stir a considerable and contentious debate between those who believe that scientific research has proven vaccines are safe and those who are adamant that further inquiry is necessary to demonstrate that vaccines do not do more harm than good.

Those who object to vaccination now are not the only ones to have ever done so—as long as vaccines have existed, so too has opposition to their use. In order to

understand why there are individuals who object to vaccines today, it was necessary to trace objections to their origin and study the patterns of thought and action that followed. After doing so, analysis of a survey of University of Mississippi undergraduates provided a glimpse of the measureable, contemporary effects such movements had on the beliefs undergraduate students hold regarding vaccination.

Figure 1.1. Community Immunity ("Herd" Immunity) (National Institute of Allergy and Infectious Diseases)

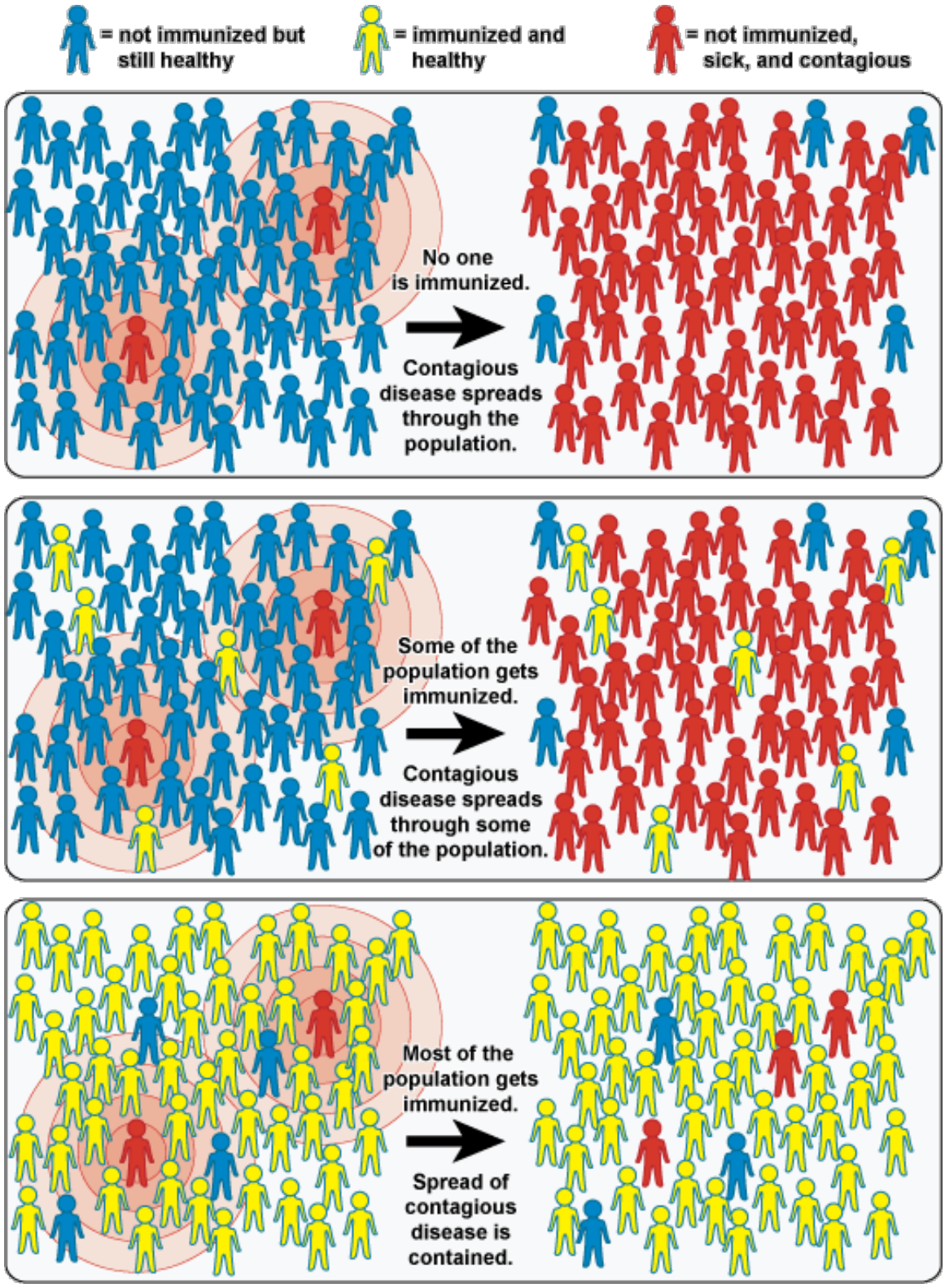
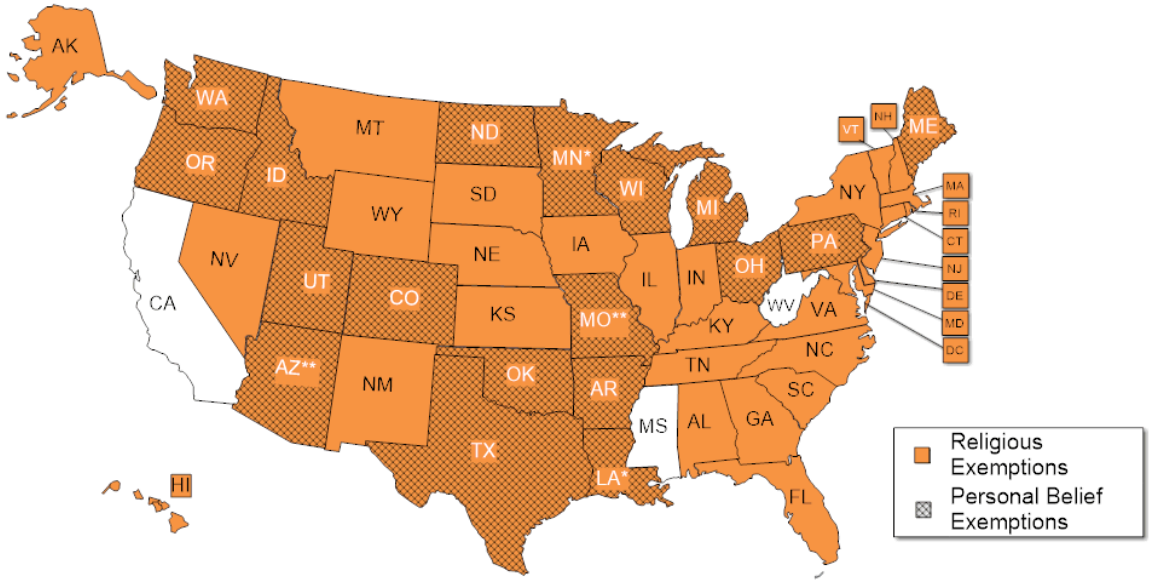


Figure 1.2. State Non-Medical Exemptions from School Immunization Requirements, 2015 (National Conference of State Legislatures)



Chapter II

Literature Review

Vaccination in its Infancy

As mentioned previously, vaccination is a technology with roots that reach back to the 16th century. This early form of immunity, derived from a process referred to as variolation, was conferred by medical professionals in Asia and western Europe by transferring lymph from lanced pustules on the skin of smallpox suffers to a small incision on the arm of an individual (Saunders, 1982; Fenn, 2001). Without causing infection, this treatment produced immunity to the smallpox virus, variola. Unfortunately, variolation had an uncertain success rate and infected two to three percent of those receiving the treatment with fatal cases of smallpox or other diseases such as tuberculosis and syphilis (Barquet, 1997; Parish, 1965). Still, variolation's benefits—the defense it provided against the deadly specter of smallpox—outweighed these risks. The procedure became a common but not ubiquitous practice in Asia, Europe, and the American colonies by the middle of the 18th century and proved to be an effective defense against smallpox outbreaks (Barquet, 1997).

In the late 18th century, English physician Edward Jenner dedicated his work to investigating the claims of countless farmers and milkmaids that their exposure to cowpox, a disease closely related to smallpox, rendered them immune to smallpox

(Fisher). Convinced that lymph from a cowpox-infected individual could confer immunity against smallpox, much like the lymph from smallpox-infected individuals, he tested this hypothesis in 1796. After extracting lymph from a milkmaid infected with cowpox and transferring it to two incisions made on the arm of a young boy, Jenner had his suspicions confirmed when the boy showed no reaction to exposure to smallpox six weeks later (Barquet, 1997). By the end of the century, Jenner's work was published, and his method of creating immunity, termed "vaccination" after the name of the cowpox virus, vaccinia, spread worldwide (Pead, 2006).

Jenner's use of biological material from another species was not met with universal enthusiasm. His treatment depended on the willingness of individuals to allow their bodies to be infected with the diseases of an animal in a post-enlightenment world where humans had been set apart as superior to all other creatures (Fulford, 2000). While variolation seemed to be a transfer of the immunity to smallpox from one person to another, vaccination raised fears that patients might be turned into a part human, part cow that was entirely an abomination. One prolific English doctor treating smallpox patients in Jamaica wrote:

> Can any person say what may be the consequences of introducing a bestial humour into the human frame, after a long lapse of years? Who knows, besides, what ideas may rise, in the course of time, from a brutal fever having excited its incongruous impression on the brain? Who knows, also, that the human character may undergo strange mutations from quadruped sympathy; and that some modern Pasiphae may rival the fables of old? (Moseley, 1805, p. 214).

Others drew their concerns about the vaccine: a popular piece of satirical caricature at the time depicted (**See Figure 2.1**) "a wild orgy of transformation where a side-glancing doctor vaccinates subjects who then sprout cows from their limbs, buttocks, mouths, and ears" (Fulford, 2000).

Figure 2.1. ***The Cow-Pock-or-the Wonderful Effects of the New Inoculation!-(Gillray).***

Early objectors not only worried about the purity of their bodies—they also objected to the compulsory vaccination campaigns that became commonplace in Europe and United States. As smallpox rates steadily decreased and the horrors of the disease became a memory in many communities by 1830, working-class groups began to

organize against what was believed to be a particularly egregious violation of liberty and privacy by the government in forced vaccination (Stern). These groups were further strengthened by alliances formed with those opposed to experimentation on animals (Baker and Davidovitch).

In addition to these objections, Jenner's method of vaccination was challenged by its dependence on deliberately infecting calves with cowpox and spreading lymph between many individuals. This not only led to outbreaks of several other diseases like syphilis with vaccination through shared lymph, but also severely limited access to vaccination due to the need for a living supply of lymph (Plotkin, 2004).

A solution to the problems of cleanliness and supply was not found until the middle of the 19th century when a team of German scientists studying the research of Robert Koch and Louis Pasteur began using glycerin to preserve lymph carrying cowpox while killing any other viruses or bacteria (Copeman, 2006; Plotkin, 2004). This discovery enabled the storage and shipment of lymph for vaccination, greatly increasing the technique's potential to spread immunity. Work by Pasteur near the end of the 19th century produced weakened forms of several additional types of viruses and bacteria including rabies, typhoid, and cholera, not only creating new vaccines, but also making vaccination a more well tolerated procedure (Plotkin, 2004).

These new vaccines were not just important because they contained weakened forms of viruses—they contained weakened viruses *that had been formed in a laboratory setting* (Galambos, 1999). Patients and medical professionals no longer depended on a live source of lymph to provide immunity: a practically limitless supply could be derived from a sterile setting by a handful of individuals. These manufactured vaccines made

from preserved samples of weakened viruses provided the contemporary definition of vaccine: a "suspension of live (usually attenuated) or inactivated microorganisms (e.g., bacteria or viruses) or fractions thereof administered to induce immunity and prevent infectious disease or its sequelae" (Advisory Committee on Immunization Practices and the American Academy of Family Physicians, 2004; Stern, 2005).

With these developments, the era of vaccination began to take shape with mass-produced smallpox vaccinations and the first vaccination programs at the end of the 19th and turn of the 20th centuries. However, these new vaccines did not assuage all misgivings the public held about their safety. With many concerns of early objectors still unanswered, so too did the era of vaccine resistance begin.

Foundations of Widespread American Discontent

By the late 19th century, vaccination against smallpox had insulated several generations of Americans against the hysteria that had accompanied smallpox outbreaks before the attenuated vaccine became the standard of care (Colgrove, 2006). This was achieved through compulsory vaccination laws that coupled smallpox vaccination with attendance at public schools, similar to modern laws that require vaccination to attend public schools. As of 1890, 11 states had such laws: Massachusetts, New York, Connecticut, Indiana, Illinois, Wisconsin, Iowa, Arkansas, West Virginia, and California. However, after these laws had been on the books for decades, many cities began to feel that they were overly intrusive measures to protect against a bygone threat and stopped enforcing the laws (Hodge, 2001).

With so many individuals regarding the threat of a smallpox outbreak with apathy, vaccination rates dropped to lackluster levels across the country. Nearby outbreaks typically spurred citizens to get their vaccinations as quickly as possible, but nothing was guaranteed (*Annual Report of the Board of Health of the City of Brooklyn for the Year 1886*, 1887). With the much more frequent threat of diseases like measles and diphtheria to deal with and such infrequent outbreaks of smallpox, some doctors even had trouble diagnosing or recognizing the disease when cases did occur, especially in its early stages. This not only put doctors at a disadvantage, but frustrated public health officials who lacked the resources and justification for the time consuming process of tracking down smallpox patients to exhibit as a training exercise. Instead, doctors were instructed to treat any sickness resembling the symptoms of smallpox, such as chicken pox, as smallpox (*Annual Report of the Board of Health of the Department of Health of the City of New York for the Year Ending December 31, 1894*, 1895).

Further complicating efforts to vaccinate citizens was the uncertainty whether immunity was worth vaccination's potential side effects. Though the use of attenuated calf's lymph was much safer than the old methods of calf-to-human and human-to-human immunity, these new vaccines still caused side effects, and in rare cases, lockjaw or death. Unscrupulous medical professionals additionally frustrated vaccinators:

> The use by some colleagues of impure or improperly prepared lymph from disreputable drug firms was a source of continuing consternation for doctors; every swollen, infected, or abscessed arm that resulted was a black eye to the profession and its effort to gain respectability with an often skeptical public. (Colgrove, 2006, p. 19)

Individuals had a choice: go without vaccination against a disease most had never seen, or receive a painful vaccination they had witness sicken the healthy. Taking advantage of this dilemma, anti-vaccination groups began to spring up across the country (Colgrove, 2004).

Because of the less-than-ideal relationship between American citizens and vaccination, health officials in Brooklyn were frustrated when an outbreak of smallpox occurred in late 1893. Not only did doctors have to treat and quarantine those who had become infected, they also needed to vaccinate as many nearby individuals as possible. Much to the chagrin of these professionals, their work was hampered by their lack of legal authority to compel individuals to receive vaccination. By 1894, the situation had become so urgent that the Mayor of Brooklyn named a new Health Department Commissioner, Dr. Taylor Emery, who greatly increased the department's resources and manpower while using de facto legal authority in order to compel residents to receive vaccinations. As the outbreak began to die down, Emery's tactics remained focused on ensuring Brooklyn's residents received their vaccinations. Teaming up with local police in order to intimidate residents into receiving their vaccinations, officials from the Brooklyn Health Department began to systematically sweep through Brooklyn's neighborhoods in a vaccination program determined to make the city immune to smallpox (Colgrove, 2006).

Officials found immigrant communities to be especially resistant to vaccination, with individuals dodging any vaccination attempts targeting them or their children. Dr. Susan R. Fray, one of the many doctors sweeping through Brooklyn, told a Brooklyn gossip column that:

> The Italians are in great fear of vaccination, and resort to all sorts of means to hide themselves and their children. If the child is small enough they will put it in the bureau drawer. I have found dozens of babies there, and my experience has taught me never to overlook the smallest nook or cranny in searching for persons in the tenement houses. One woman whom we vaccinated admitted that she had escaped inoculation on four previous visits of the Health Department's vaccinators by crawling under the bed, and she bewailed her luck in at last getting caught. ("The News of Brooklyn," p. II.10)

These immigrants, fleeing countries with heavily enforced vaccination laws, appeared reluctant to give up the liberty they believed separated the United States from their home countries (Colgrove, 2006).

Soon, Emery's harsh tactics met opposition in more and more places across Brooklyn, no longer limited to pockets of immigrants and the working class. He became a fixture in the *The Brooklyn Daily Eagle*, where he defended his methods and asserted his legal authority to compel the citizens of Brooklyn to receive vaccinations (Colgrove, 2006). In an interview in 1894, Emery defiantly stood in opposition to the arguments of his critics, who said that he had gone too far in not only forcing citizens to receive vaccinations, but also quarantining these individuals until they did so:

> The law clothes the department with ample authority to do all which it deems necessary, and it is pursuing a systematic course of vaccination, disinfecting, and quarantining…For the most part the citizens have shown a patriotic readiness to submit to all these avoidable inconveniences and to assist the department in every possible way. In the few cases where

> selfishness and unreasonableness have led to opposition the officials have considerately but firmly on carrying out their instructions. ("Vaccination is Safe," 1894)

No matter how caustic Emery's comments may have been, especially to the immigrant communities he targeted, his words resonated across the country. *The New York Times* in nearby New York (still a separate city in 1894) frequently appealed to his arguments as an example of actions that should be taken to prevent smallpox outbreaks there. Similarly, statewide health officials in both Wisconsin and Minnesota lobbied officials in Milwaukee and Chicago to use Emery's tactics in order to avoid outbreaks of smallpox that could incubate in these cities before spreading to their states (Colgrove, 2006). Emery's tactics also held their own on several occasions in court, with various plaintiffs failing to prove that the Brooklyn Department of Health abused its authority or caused harm to any individual. However, none of these cases definitively decided whether the government could force or compel an individual to receive a vaccination (Colgrove, 2004).

Jacobson v. Massachusetts

Reeling from a devastating smallpox epidemic that struck between 1901 and 1903, the city of Cambridge, Massachusetts passed a law that mandated all citizens who had not undergone vaccination against smallpox do so. Soon after this, a Lutheran pastor named Henning Jacobson refused to receive a vaccination when asked, and also refused to pay the fine for not getting vaccinated. Jacobson was forced to make his case in front of the local district court, where he failed to convince the judge that past reactions to a

vaccination and his personal belief that compulsory vaccination laws violated the United States Constitution were a valid reason to refuse a smallpox vaccination (Mariner, 2005). His case wound its way all the way to the Supreme Court, which upheld the original ruling.

In their opinion, the majority affirmed the right of the Commonwealth of Massachusetts to use its power to compel an individual to receive a vaccination in order to protect public health, stating:

> The defendant insists that his liberty is invaded when the State subjects him to fine or imprisonment for neglecting or refusing to submit to vaccination; that a compulsory vaccination law is unreasonable, arbitrary and oppressive, and, therefore, hostile to the inherent right of every freeman to care for his own body and health in such way as to him seems best, and that the execution of such a law against one who objects to vaccination, no matter for what reason, is nothing short of an assault upon his person. But the liberty secured by the Constitution of the United States to every person within its jurisdiction does not import an absolute right in each person to be, at all times and in all circumstances, wholly freed from restraint. There are manifold restraints to which every person is necessarily subject for the common good. (Jacobson v. Massachusetts, 1905)

The implications of this court case on public health law are overwhelming:

> While Jacobson stands firmly for the proposition that police powers authorize states to compel vaccination for the public good, government

> power must be exercised reasonably to avoid constitutional scrutiny. The acts of a board of health, it has been held, are limited to those which are essential to protect the public health. States, for example, could not impose vaccination on a person who is hyper-susceptible to adverse effects such as a severe allergic reaction. (Hodge, 2002)

This power, and the limits on it, laid the foundation for public health policy that would be made for the rest of the 20th century.

Anti-vaccination Movement in the Early Progressive Era

In the decade that followed the 1905 decision in *Jacobson v. Massachusetts*, surprisingly little was done to increase the vaccination rates against smallpox across the United States. Though the case laid the groundwork for sweeping vaccination programs that could be compelled using force, such actions proved to not be necessary. Incidences of smallpox steadily decreased across the country, in part due to cleaner living conditions and the peculiar appearance of a much weaker strain of smallpox, variola minor, that became the dominant strain of smallpox across the United States. Smallpox was no longer the feared and dreaded pestilence that swept through cities and towns and indiscriminately killed populations—instead, it now resembled chicken pox and rarely took the lives of those who contracted it. There was growing sentiment that vaccinations were not only unnecessary for such a minor disease, but also an unsafe practice that could result in serious illness or death. No matter how many times these claims were refuted by public health officials and experts, they still persisted (Colgrove, 2006).

Something more serious was driving vaccination rates down and membership in anti-vaccination groups up, though. With advancements in technology at the end of the 19th century, vaccines against a growing number of diseases were becoming available. Though these promised to make a number of serious diseases a memory like smallpox, many people remained unconvinced that these provided a benefit to the human body and were skeptical that they could confer promised cures. Furthermore, many began to wonder whether these treatments were worth the liberty given up when forced by the government to receive them. Public health expert James Colgrove writes:

> Although the promise of scientific innovations usually exceeded their actual benefits, they attracted enthusiastic and often breathless coverage in the popular press. Newspaper and magazine articles trumpeted the prospect that other diseases would soon yield to the principles of immunization that had brought smallpox under control, expressing the hope that prophylactic "serums" to combat diseases as diverse as tuberculosis, pneumonia, and cancer might soon be developed. But these advances also provoked an anti-modernist backlash against the paternalist and potentially coercive uses to which scientific medicine might be put. Anti-vaccination literature of the period reflected a pervasive fear that the new vaccines and treatments—with all of their unknown and untoward side effects—would be made mandatory. (2006)

In order to advocate and advance these beliefs, several major anti-vaccination groups organized across the United States. Most notable of these groups were the Anti-Vaccination League of America, Citizens Medical Reference Bureau, and the American

Medical Bureau. Fighting from the beginning of the century through the 1920s, these groups lobbied state legislatures and local governments to scale back state powers that compelled citizens to receive vaccinations. Though the arguments made by these groups varied between liberty, safety, and religious rights, they coordinated their efforts and often worked together. Though these groups had nearly no luck scaling back the laws, they did succeed in convincing many school districts across the country to look the other way when enforcing compulsory vaccination and justifying the large numbers of Americans that avoided vaccination due to discomfort. Because of this, vaccination slumped from 1905 through 1930, which allowed for sporadic outbreaks of smallpox. However, as many vocal leaders of the movement began to pass away in the 1920s, vaccination rates again to began to rise (Colgrove, 2006).

Diphtheria and the Goal of Eradication

As the most prominent detractors of vaccination began to pass from the scene in the late 1910s and early 1920s, German researcher Emil Behring developed a vaccine to introduce diphtheria immunity (Colgrove 2006). This preparation was distinctly different from past vaccines—instead of solely introducing an attenuated form of infectious material into a patient's body, this vaccine depended heavily on the diphtheria antitoxin, an antibody produced by the human body in response to diphtheria infection. This antitoxin and the immunity it conferred was discovered by American researchers at the end of the 19th century, who found that introducing children sickened by diphtheria to diphtheria antibodies cultured in a laboratory exponentially increased their chances of survival (Hammonds, 1999). By taking this antitoxin and combining it with an amount of

attenuated diphtheria toxin much smaller than the amount of toxic material found in vaccinations against other diseases, doctors could provide immunity against diphtheria with fewer side effects. As Colgrove describes, this increased safety made the toxin-antitoxin immunization much more palatable to the public:

> From the patient's standpoint, diphtheria immunization was a far milder experience to undergo than smallpox vaccination. Unlike the multiple small abrasions to the arm that were made in (smallpox) vaccination, toxin-antitoxin was administered through a hypodermic needle, and thus did not leave a scar. It often caused a small swelling around the injection site, and occasionally a transient mild fever, but reactions were generally negligible, and the doubts about safety that clung to (smallpox) vaccination never developed around toxin-antitoxin. (Colgrove, 2006)

But the diphtheria immunization had a major, unintended side effect: it began the first of many public health quests to eradicate disease once and for all instead of using vaccines to fight ubiquitous disease outbreaks. With smallpox vaccination hindered by painful administration, side effects, and less-than-ideal levels of urgency, the comparatively simple diphtheria vaccination conferred immunity with nearly no drawbacks. Efforts of public health officials shifted from using compulsion to persuasive strategies and increased access to convince citizens that it was their duty to be vaccinated. With this new, safer vaccine, the public began to buy in. Pilot campaigns across the largest cities in New York and New Jersey were massively successful: by inundating their populations with pamphlets, billboards, radio broadcasts, magazine advertisements, traveling health clinics, and free or low-cost vaccination drives, rates of diphtheria

immunization skyrocketed to near 50 percent by the end of the 1920s (Colgrove, 2006; *City of New York Department of Health Annual Report 1929*; Palmer, Derryberry, Van Ingen, 1931). Comparatively, less than 5 percent of these same populations were vaccinated against smallpox.

Unfortunately, these first eradication campaigns did not find long-term success. Groups such as chiropractic practitioners began distributing materials that questioned whether widespread vaccination against a disease with a low mortality rate and infrequent outbreaks like diphtheria was truly necessary and asserted that this diphtheria immunity could cause health problems later in life (*Chiropractic News*, 1929). More harmful to diphtheria immunization, however, was the success of the program. With fewer and fewer cases of diphtheria, public health officials struggled to convince the general public that diphtheria was a threat worth being vaccinated against. On top of this, many doctors were uncertain whether the vaccine could weaken immunity against other diseases, and many ethnic communities such as Italian-Americans remained hostile toward all immunization (Colgrove, 2006; *New York Times*, 1930; *New York Times*, 1931; Hammonds, 1999). Though the goal of diphtheria eradication was not met, the tactics used in pursuing such a goal provided valuable practice and experience that would later guide health officials seeking to eradicate polio in the United States.

Eradication of Polio in the United States

Though cases of polio can be traced back for thousands of years, the disease did not make its way to the United States until the late 1800s, and the first widespread

American outbreak did not occur until 1916 (Colgrove, 2006). Though the virus responsible for causing polio, poliovirus, was isolated in 1908, researchers struggled through the 1950s to determine its exact mechanism of infection and how it was transmitted from person to person (Rogers, 1992). In most cases, polio only causes flulike symptoms, but in severe cases, it can cause paralysis that can prove deadly without assistance from negative pressure ventilators, colloquially referred to as "iron lungs."

President Franklin Delano Roosevelt notably fell ill with polio in his late 30s. He served as Governor of New York for one term and President of the United States for three terms while paralyzed from the waist down as a result of the infection (Fairchild, 2001). Though he deliberately hid the full extent of his disability that polio left him with from the general public, he became the popular face of the movement to find a cure for polio, establishing the National Foundation for Infantile Paralysis (NFIP), whose fundraising campaign "March of Dimes" sponsored research into a polio vaccine (Smith, 1990).

This NFIP research produced the most promising results in the search for a treatment or vaccine. Researcher John Enders was able to culture the polio virus in human tissue from locations other than the nervous system in 1949, showing that the virus not only affected the nervous system as previously believed, but also spread to other systems of the body (Benison, 1972). Using this information, two researchers, Albert Sabin and Jonas Salk developed two different vaccines that promised to provide immunity. Sabin's vaccine depended on an attenuated form of the poliovirus, while Salk's used an inactivated form of the virus. Experts at the NFIP determined that Salk's vaccine had the most potential to counter the growing number of polio infections and funded large-scale production and human trials (Paul, 1971; Colgrove, 2006).

Following trials on nearly 2 million children through 1954 to 1955, the vaccine was approved for use in humans and the NFIP quickly made plans to buy nearly $10 million of the vaccine and distribute it across the country to target groups of pregnant women and boys and girls under the age of 20 (Colgrove, 2006; Carter, 1966). Though an early shipment of the vaccine caused rare cases of paralysis due to being improperly inactivated, confidence in the vaccine remained strong: fewer than 1 percent of New York City parents refused to vaccinate their children (Colgrove, 2006; Cutler, 1955).

Just one year after the vaccine had been introduced, polio vaccination rates stagnated even though age restrictions had been lifted. Though there was some public opposition, movements to refuse the vaccine were based in fringe conspiracies like communist and Jewish plots to damage American liberty (Colgrove, 2006; Schreiber, 1956). Instead, the decline in vaccination rates was attributed to what New York City Health Commissioner Leona Bumgartner described in a letter as "general apathy about the whole situation" (Colgrove, 2006; Bumgartner 1956). To combat this, health officials undertook three measures. First, public outreach programs to increase awareness of the vaccine's availability were initiated nationwide, including the photographed and widely distributed vaccination of Elvis Presley in 1956 (New York Times, 1956). Second, vaccination efforts nationwide were shifted from targeting the general public to reaching groups underrepresented in these original efforts, including rural communities and the poor. While plans were considered to make polio vaccination mandatory, most of these never materialized (Colgrove, 2006). Finally, in 1961, the United States Public Health Service began the process of licensing Sabin's attenuated vaccine, which could be given orally and distributed more easily than Salk's inactivated vaccine, which required

injection (Sabin, et al., 1961; Paul, 1962). By 1967, there were fewer than 100 cases of polio per year in the United States, and the entire country was declared free of polio in 1979 (Colgrove, 2006; Centers for Disease Control, 2015).

Measles and Backtracking to Compulsion

Emboldened by efforts to eradicate smallpox and polio in the United States and across the world, the American Public Health Association (APHA) announced in November 1966 their plans to eradicate measles from the country by the end of 1967. This was an unprecedented effort, rooted in a measles vaccine developed in 1963 and an ambitious four-point plan that sought to immunize all children at the age of one, immunize all public school students, closely monitor measles cases across the country, and develop contingency plans to rapidly stop any measles epidemics. After teaming up with the CDC in 1967, the APHA's plan became one of President Lyndon B Johnson's efforts to raise the quality of life across the country (Colgrove, 2006).

As communities across the country embraced these new goals, public health authorities dedicated massive amounts of resources and manpower to making them a reality. While measles was not eradicated by the end of 1967, the plan appeared to be a success: there were only 22,000 cases of measles in 1968, compared to an average of 450,000 per year in the five years prior, and rates of vaccination for one through nine year olds hovered between 50 and 60 percent (Colgrove, 2006; Hinman et al. 1979). However, by 1971, there were more than 71,000 annual cases, and vaccination rates remained unchanged (*Report and Recommendations*, 1977). Those evaluating the

shortcomings of the plan found three problems: an underestimation of the vaccination rate required to stop measles outbreaks, poor access in low income and rural communities, and structural failures within the bureaucracies administering the vaccinations (Colgrove, 2006).

Regardless of the source of the failures, policymakers across the country began to consider whether the lack of compulsory vaccination laws in many states was detrimental to the vaccination programs forced to rely solely on persuasion and marketing. In 1968, 25 states had compulsory vaccination laws tied to public school enrollment, most of which had been authored as part of the measles eradication campaign. By 1974, the number jumped to 40, and in 1981, the number reached 50 (Colgrove, 2006; Hale, 1981). However, as Colgrove notes, many of these laws did not fully mandate that all children attending public school receive vaccinations:

> Unlike mandates in the nineteenth century, almost all of the new laws contained exemptions for children whose parents had religious scruples against the practice…Legislators in some states wrote their exemptions narrowly, out of concern that too liberal a policy would encourage parents to opt out. Some laws allowed exemptions only for members of "recognized" or "established" religious denominations whose tenets specifically proscribed vaccination…while others allowed local education officials the discretion to waive the requirement as they saw fit. (Colgrove 2006)

Nevertheless, these mandatory vaccination laws proved to be a great source of controversy in the decades to come.

Opposition to DPT

Rachel Carson's *Silent Spring*, the 1962 book criticizing the unchecked effects of rampant pesticide use across the United States, signaled the beginning of a new, prominent environmental movement. This movement focused concern on "radiation, heavy metals, pesticides, and chemicals" and contributed to the passage of a number of national polcies focused on protecting the natural environment, including creation of the Environmental Protection Agency (Conis, 2015). This new movement popularized an "ecological view of health," linking environmental factors such as pollution to the health and wellbeing of humans (Conis, 2015). It was this perspective that turned the attention of many environmentalists to Eleanor McBean's 1957 book *The Poisoned Needle.* McBean asserted that vaccination caused more harm than good by polluting the human body, disrupting the natural cycle of disease and health, and devastating the body's natural protection against disease, causing more frequent outbreaks of disease. Though never a bestseller, her argument drove a new ideological opposition against vaccination still visible today.

The first visible manifestation of this new resistance was opposition to the combined diphtheria, pertussis, and tetanus (DPT) vaccine used in the mid 1970s. After a British study noted the risk of severe neurological damage as a possible rare side effect of the anti-pertussis part of the vaccination, vaccination rates in Britain plummeted by more

than 50 percent by 1978 (Kulenkampff, Schwartzman, and Wilson, 1974; Gangarosa et al., 1998). These vaccine fears made their way to America in 1982, when a documentary titled "DPT: Vaccine Roulette" aired across the country. Focusing on the side effects caused by the DPT vaccine to American children, the documentary was dismissed by health professionals as only depicting a negligible risk and ignoring the great benefits that vaccination against diphtheria, pertussis, and tetanus provided. But this call for caution and prudence was not heeded: a group called Dissatisfied Parents Together soon formed, uniting those against the vaccine on principle, those concerned about its safety, and those who believed they had children negatively affected by the vaccine. This group lobbied Congress and filed a number of class action lawsuits with the goal of providing financial compensation to potential vaccine and taking the vaccine off the market. By 1986, the cost of the vaccine had risen from ten cents to three dollars, and the annual number of court cases against its manufacturers exploded from two to 250 (Colgrove, 2006; Freed, Katz, and Clark, 1996; United States, 1987). As a result, Congress passed the National Childhood Vaccine Act of 1986, which provided guaranteed medical care and monetary damages in any cases of vaccine-related injuries and deaths, required vaccine manufacturers to undertake measures to improve vaccine safety, and created the Vaccine Adverse Event Report System, a CDC and FDA program to track vaccine injuries and deaths across the country (Colgrove, 2006; Evans, Harris, and Levine, 2004). Interestingly, unlike the drop in vaccine coverage observed in Britain, vaccine rates against diphtheria, pertussis, and tetanus remained steady through the American debate over DPT safety (Colgrove, 2006).

MMR and Contemporary Challenges

Through the 1990s, skepticism regarding the efficacy and safety of vaccines grew steadily and found a national audience. National newspapers and programs began to air segments and print pieces investigating potential hidden dangers in vaccines, looking for a link between claimed side effects and vaccination. CDC officials, the National Institutes of Health, and Institute of Medicine teamed up to field a panel of experts to identify the most prominent concerns and determine whether there was any basis to the claims of links between:

> …vaccines and sudden infant death; flu vaccine and neurological complications; polio vaccines and cancer; hepatitis B vaccine and neurological disorders; vaccines and immune dysfunction, thimerosal and neurodevelopmental disorders; and MMR vaccination and autism. (Conis, 2015; Institute of Medicine, 2004).

Though no links between any of these conditions and vaccination were found, these claims stuck and vaccine fears did not evaporate. One claim, however, gained greater prominence than the others: the claim that the MMR vaccine causes autism. Though claims had been made about a link between many vaccines and autism, a supposed link between autism and the MMR vaccine caught international attention. Bolstered by a 1998 study by British medical doctor Andrew Wakefield that claimed to find a connection between twelve autistic children and their vaccination against MMR, anti-vaccine activists now appeared to have scientific data on their side (Wakefield et al., 1998).

Despite the article's later retraction and no further studies showing a link between autism and vaccination, the statement stuck, and more claims against the safety of vaccines were being made and are still being made today. In contrast to the generations of anti-vaccination, current vaccine skeptics have the Internet (Colgrove, 2006). With more and more parents turning to the Internet to research the medical choices they make for their children, they are being faced with alternative medical advice promulgated by anti-vaccine groups. A study using the American version of Google found that 71% of the top results for the search query "vaccination" were sites advancing anti-vaccination claims, highlighting the vast amount of anti-vaccine sentiment sheltered on the internet and the high level of traffic these sites enjoy (Kata, 2010). Once on these sites, visitors are provided with unambiguously anti-vaccine content, including false claims about the safety of vaccines, alternative treatment suggestions, and guides on how to take advantage of vaccine exemptions in each state (Kata, 2010; Colgrove, 2006).

Three distinct eras of vaccine refusal have occurred and informed the beliefs of a great deal of Americans for over 200 years. The first era began with the creation of the first vaccine at the end of the 18th century and continued through the middle of the 19th century, with a great deal of conflict surrounding vaccination's uncertain long-term effects and the legal implications of compulsory vaccination. A second era occurred at the end of the 19th century and lasted through the start of 20th century, with misgivings defined by dangerous side effects, skepticism of the efficacy of public health programs, and continued legal struggles. Finally, a third era beginning in the mid 20th century and lasting through the present day is characterized by allegations that current vaccine formulations can cause devastating neurological side effects and the use of new

technologies like internet and television to spread fear of dangers of vaccination. With this historical background, it is important to evaluate the vaccine beliefs of the present day.

Chapter III

Current State of Vaccination

The United States, generally speaking, has high vaccination rates. The CDC's 2014 edition of the National Immunization Survey (NIS), an annual survey of "national, regional, state, and selected local area vaccination coverage estimates" for children between 19 and 35 months of age, reported stable and robust vaccination rates across the country as a whole. The report found that fewer than 1% of children across the country had received no vaccinations, and target goals of 90% coverage were met for at least one dose of the MMR vaccine (91.5%) (Estimated Vaccination Coverage with Individual Vaccines and Selected Vaccination Series Among Children Aged 19-35 Months by State and Selected Area, Hill et al.).

However, results of the survey also showed that the target goal of 90% coverage for four doses of the DTaP (diphtheria, tetanus, and acellular pertussis) vaccine had not been met, instead staying steady at a rate of 84.2%. This is especially concerning because pertussis, known also as whooping cough, is highly infectious with frequent serious complications including pneumonia, slowed breathing, and death. The highly transmittable nature of pertussis infections give it a high herd immunity threshold between 92 and 94%, meaning at least 92 – 94% percent of a population must be vaccinated to prevent outbreaks within it (Hill et al., Smith).

Equally disconcerting is the number of states with vaccination rates below the minimum threshold required for herd immunity for measles and rubella. Arizona, Colorado, Oregon, Utah, and Washington have MMR vaccination rates with margins of error that fall well below the lower threshold of 83% required to prevent outbreaks. As mentioned in Chapter I, these five states allow for ideological and religious exemptions from vaccination, suggesting a correlation between these exemptions and communities that are the sites or potential sites of outbreaks of vaccine preventable diseases. The authors of the CDC report note the holes in coverage in certain regions of the country with alarm, stating:

> Geographic variation in coverage can result in pockets of susceptibility even for vaccinations associated with high national coverage, such as MMR. During the first 3 months of 2015, a total of 159 measles cases from 18 states and the District of Columbia were reported to CDC. Four outbreaks were identified, and >80% of cases occurred among unvaccinated persons or persons with unknown vaccination status. The largest outbreak was associated with Disney theme parks in California, accounting for 111 (70%) of the cases reported before the beginning of April 2015. Although the United States reported elimination of indigenous measles transmission in 2000, about 20 million measles cases still occur worldwide. Importation of measles from other countries remains a risk for unvaccinated U.S. residents, emphasizing the need for continued vigilance and maintenance of high vaccination coverage. Increasing DTaP coverage should also be an area of enhanced effort. A total of 28,660 pertussis cases

> were reported to CDC during 2014, a slight increase over the final case count of 28,639 reported in 2013. (Hill, et al.)

It is apparent that the CDC's concerns are well founded. The Council on Foreign Relations found that at least 310 outbreaks of measles, mumps, and pertussis have occurred in the U.S. between 2008 and 2015, while the CDC reports that these same diseases sickened at least 160,000 individuals between 2008 and 2013 (Garrett, Epidemiology and Prevention of Vaccine-Preventable Diseases). Though the NIS report notes that there have been statistically significant decreases in vaccination rates among individuals below the poverty line, these were not found to be responsible for outbreaks of vaccine preventable diseases (Hill et al.) Rather, it is these gaps in coverage clustered in certain states or communities with high exemption rates that are ground zero for the most widespread outbreaks (Garrett).

Recent survey data suggest that a significant minority of Americans does not universally support vaccines. A poll published by the Pew Research Center in February of 2015 found 83% of their sample believed that the MMR vaccine is safe, while 9% do not and 7% did not know. The same study found 15% of 18-29 year olds do not believe the vaccine is safe, compared to 10% of individuals aged 30-49, 6% of those age 50-64, and 4% of those age 65+. In addition to age, education played a big role in the respondents' answers: 5% of those with a college degree believe the MMR vaccine is not safe, while 14% with a high school diploma or less said the same. The reasons respondents believe the vaccine is unsafe vary, ranging from personal experience, to a distrust of vaccine producers, to a belief that the MMR vaccine causes autism ("83% Say Measles Vaccine Is Safe For Children).

Another survey by the Pew Research Center published in January of 2015 found that within their sample of adults in the United States, 30% believed that parents should decide what vaccinations their children receive, compared to 68% who believed that all children should be vaccinated. These beliefs were consistent across differing levels of education, however, age and whether a respondent was a parent or not played a major role in their answers. The younger the respondent, the more likely they were to support parental choice: 41% of adults aged 18- 29, 35% of adults aged 30-49, 23% of adults aged 50-64, and 20% of adults age 65+. Among parents, 34% believed that parents should decide, compared to 28% of adults without children ("Young adults more likely to say vaccinating kids should be a parental choice").

American adults appear to hear more about the benefits of vaccination than about any possible disadvantages. A Gallup survey published in March of 2015 found that 83% American adults surveyed had heard a great deal or fair amount about the benefits of vaccination, compared to 73% responding they had heard a great deal or fair amount about its disadvantages. A large majority believed vaccines to be a vital medical tool—84% answered that childhood vaccinations were "extremely" or "very" important. This sample seemed reluctant to call vaccinations harmful—only 9% responded yes to a question asking whether vaccines were more dangerous than the diseases they protect against, and 6% responded affirmatively to a question asking whether certain vaccines could cause autism. However, 52% of respondents were unsure whether there is a link between vaccines and autism ("In U.S., Percentage Saying Vaccines Are Vital Dips Slightly").

There is obvious cause for unease in these data that can be traced back to the present controversies surrounding vaccination. Low rates of MMR coverage in states allowing ideological and religious exemption, significant uncertainty regarding vaccine safety, and widespread circulation of anti-vaccine beliefs are all direct consequences of anti-vaccine movements. With these happenings having the potential to contribute to outbreaks of vaccine-preventable diseases, measuring the effects of anti-vaccine movements provides an opportunity to assess their strength and reach.

Chapter IV

Methodology

Measuring the vaccine beliefs of University of Mississippi students not only provided a way to measure collective opinion of vaccination held by undergraduates on the University of Mississippi campus, but also presented an opportunity to identify the effects of past and present anti-vaccine movements. To gain insight into the opinions of University of Mississippi students on vaccination, I conducted a quantitative study of the attitudes on vaccines and childhood vaccination held by University of Mississippi students.

Survey Design

In order to complete the study, I developed a survey with three sections of questions. First, I asked a series of demographic questions to verify the respondent was a student of at least 18 years of age, as well as to gather information on the respondent's academic major, transfer status, academic classification, state or country of residence, and financial aid status. Next, I asked a series of yes/no questions in order to determine the respondents' views on key vaccine and childhood vaccination issues. Finally, I asked respondents to register the extent to which they agreed with 15 vaccine-related statements on a 5 point Likert scale ranging from "strongly disagree" to "strongly agree" as a way to more accurately gauge respondents' strength of beliefs.

The survey was based heavily on a questionnaire published in the World Health Organization's (WHO) *Report of the SAGE Working Group on Vaccine Hesitancy*. This report, published in November 2014, details the findings and recommendations of the WHO's Strategic Advisory Group of Experts on Immunization (SAGE) on measuring and combatting vaccine hesitancy, a term the group described as "(the) delay in acceptance or refusal of vaccines despite availability of vaccination services." This group, comprised of public health experts from around the globe, developed a questionnaire intended to measure vaccine hesitancy in communities across the world. Due to variables in socioeconomic conditions in different regions, the group recommended that the specific questions and order of the questions be changed depending on where the questionnaire was to be used (World Health Organization, 2014).

Survey Development and Distribution

I designed my survey using Qualtrics survey software licensed through the University of Mississippi and hosted on the Qualtrics website. Skip logic was used to prevent respondents indicating that they were under 18 years of age and/or not a student at the University of Mississippi from completing the survey. The survey took roughly 10 minutes for respondents to complete.

Because the survey was hosted online, potential respondents were solicited through their University of Mississippi student email accounts. A panel of 5,000 University of Mississippi student email addresses were supplied by the University of Mississippi Office of Institutional Research, Effectiveness, and Planning in order to serve

as the survey sample. The sample was randomly selected and stratified for gender, ethnicity, and academic classification in order to be representative of the University of Mississippi student population.

The survey was sent out via email on September 15th, 2015, and a reminder email was sent out 8 days later on September 23rd. The survey was closed on September 30th. 384 responses were received, and 69 responses were deleted due to being incomplete or respondents indicating they were under 18, not a student, or a graduate student.

Analysis Methods

Qualtrics survey software was also used to analyze completed survey data. The software's cross tabulation function was used to provide both descriptive statistics (univariate and bivariate) as well as chi-squared tests. Responses were analyzed descriptively by demographic category and by their responses to individual questions. Chi-squared tests were used similarly in order to analyze significance of responses by demographic category and by responses to individual questions. A *p*-value of 0.05 was used as the significance value in all chi-squared tests.

Chapter V

Results and Analysis

Demographic Results

The full text of all questions can be found in a table following this section (**See Table 5.1**) After removing all invalid responses, there were 315 survey responses. Of those 315 respondents, 224 (71.8%) were female and 89 (28.2%) were male. This more than 2-to-1 ratio of females to males is far from representative of the University of Mississippi campus, which is 54.2% female and 46.4% male, but fits with research showing that women are more likely to respond to survey requests than men.

46.3% of respondents indicated they were residents of Mississippi, while 53.7% percent were not. This is somewhat representative of the undergraduate population of the University of Mississippi campus, where 52.6% of students are from in-state and 47.4% are from out-of-state.

Respondents were 32.3% freshmen, 17.7% sophomores, 23.5% juniors, and 26.5% seniors (**See Figure 5.1**). This is close to being representative of the university population, which is 33.4% freshmen, 22.2% sophomores, 20.8% juniors, and 23.6% seniors.

In terms of major, 33.2% respondents indicated they were studying natural science or math, 21.8% social sciences or journalism, 20.5% accounting or business, 16.4% humanities major, and 8.1% engineering,. (**See Figure 5.2**). While the university does not have data on student majors in these exact categories, 66.7% are studying a liberal arts, journalism, education, applied sciences, pharmacy, or general studies major, 24.5% of students are studying an accounting or business major, and 8.8% are studying an engineering major. After adding humanities, natural science or math, and social sciences or journalism majors in order to group similarly to the university dataset, 71% of all respondents are in such a classification. So, this is a representative sampling of the campus population by major (University of Mississippi).

Table 5.1. Survey Questions Part 1

1. Are you at least 18 years of age?
❍ Yes
❍ No
2. What is your sex?
❍ Male
❍ Female
❍ Do not wish to say
3. Are you a student?
❍ Yes
❍ No

4. What category does your major fall under?
❍ Accounting and Business
❍ Engineering
❍ Humanities
❍ Natural Sciences and Mathematics
❍ Social Sciences and Journalism
❍ Graduate Student
5. Are you a transfer student from a 2 year college?
❍ Yes
❍ No
6. What is your academic classification?
❍ Freshman
❍ Sophomore
❍ Junior
❍ Senior
❍ Other _____
7 In which state or country is your primary/permanent residence?
_____
8. Do you receive need-based financial aid (student loans, grants, scholarships) to attend Ole Miss?
❍ Yes
❍ Maybe
❍ I don't know
❍ No

9. Do you believe that vaccines can protect children from serious diseases?
❍ Yes
❍ No
10. Do you believe that childhood vaccinations are necessary to prevent the spread of disease?
❍ Yes
❍ No
11. Do you believe that all healthy children should be vaccinated?
❍ Yes
❍ No
12. Do you believe that childhood vaccinations are safe?
❍ Yes
❍ No
13. Do you believe the benefits of childhood vaccination outweigh any risks?
❍ Yes
❍ No
14. Do you believe there are other, better ways to prevent vaccine preventable diseases than with a vaccine?
❍ Yes
❍ No
15. Do you believe that children receive too many vaccines?
❍ Yes
❍ No

16. Do you believe that some vaccines have the potential to cause autism in children?
❍ Yes
❍ No
17. Do you know of anyone who has had a serious reaction to a vaccine?
❍ Yes
❍ No
18. Do you understand how vaccines work?
❍ Yes - completely
❍ Yes - somewhat
❍ No
19. Do you trust your health care provider to honestly tell you about the risks and benefits of vaccines?
❍ Yes
❍ No
20. Have you or would you ever refuse a vaccination for yourself?
❍ Yes
❍ Maybe
❍ No

21. Why have you or would you refuse a vaccination for yourself?
❍ I did not believe it was necessary
❍ I could not afford the vaccination
❍ I did not think it was effective
❍ I did not think it was safe
❍ I heard or read negative media
❍ I had a bad experience with previous vaccination
❍ I know someone who had a bad reaction
❍ I know someone who told me the vaccine was not safe
❍ I do not believe in vaccination
❍ Religious belief
❍ Other _____
22. Have you or would you ever refuse a vaccination for your child?
❍ Yes
❍ Maybe
❍ No
23. Why would you refuse a vaccination for your child?
❍ I did not believe it was necessary
❍ I could not afford the vaccination
❍ I did not think it was effective
❍ I did not think it was safe
❍ I heard or read negative media
❍ My child had a bad reaction to a previous vaccination
❍ I know someone whose child had a bad reaction
❍ I know someone who told me the vaccine was not safe
❍ I do not believe in vaccination
❍ Religious belief
❍ Other _____

Figure 5.1. Academic Classification

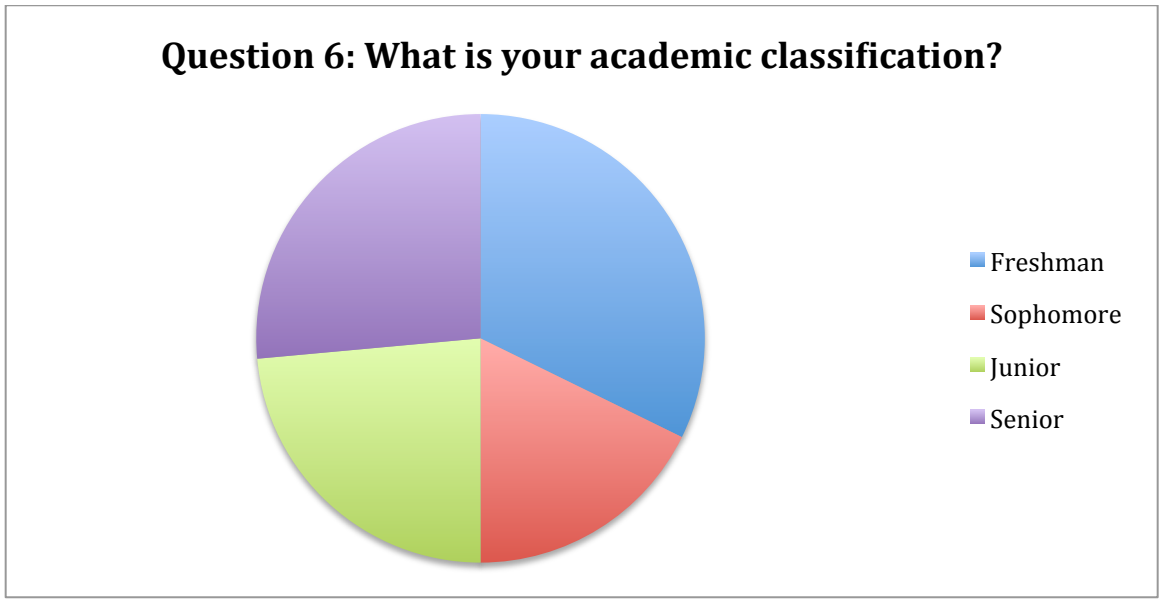
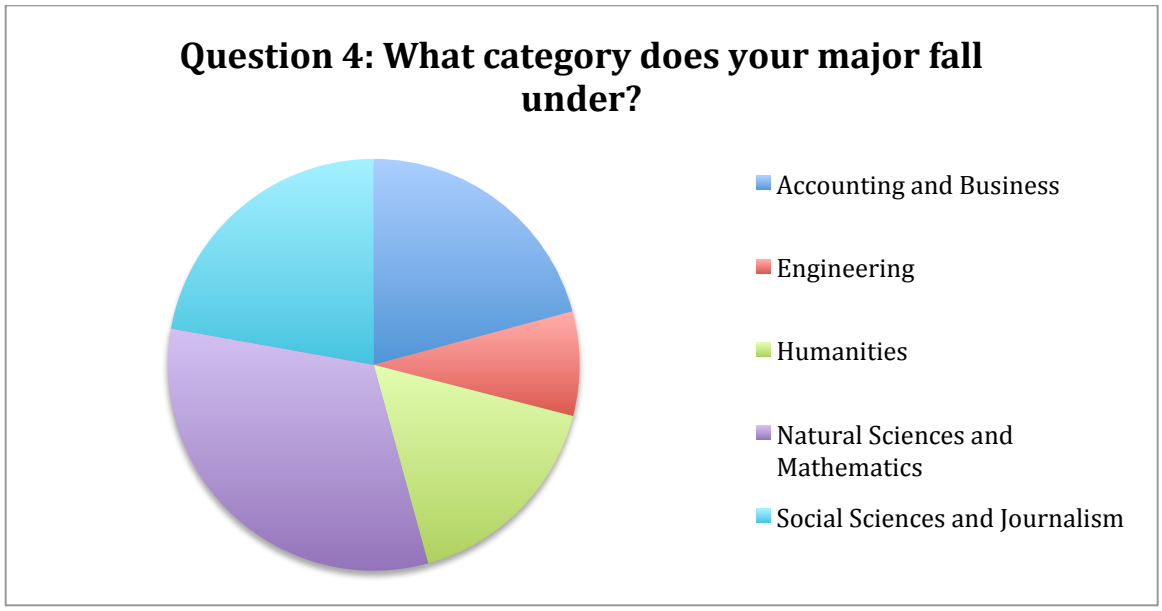


Figure 5.2. Academic Major Category



General Responses – First Section

The full text of these questions can be found in **Table 5.1**. Survey respondents answered overwhelmingly in support of childhood vaccination. 97.5% answered "yes" when asked, "(d)o you believe that vaccines can protect children from serious diseases?" Similarly, 93% answered "yes" when asked, "(d)o you believe that childhood vaccinations are necessary to prevent the spread of disease?" When asked if "all healthy children should be vaccinated," 89.5% responded "yes." They were also abundantly confident that they knew how vaccines work—98.4% answered that they completely or somewhat understood how vaccines work.

Respondents also registered strong support of the safety of vaccines and vaccination. 90.8% of respondents responded "yes" when asked, "(d)o you believe that childhood vaccinations are safe?" When asked if they "believe(d) the benefits of childhood vaccination outweigh(ed) any risk," 87% answered "yes."

However, two questions appeared to somewhat temper some of the enthusiasm respondents had for vaccination. 23.9% of respondents answered "yes" when asked if they "believe(d) that there were other, better ways to prevent vaccine preventable diseases than with a vaccine." When asked if they "believe(d) some vaccines had the potential to cause autism in children," 22.6% responded "yes."

Several other questions pointed to a skeptical attitude a substantial minority held towards vaccination. Asked whether they believed "children receive(d) too many vaccinations", 19.5% answered "yes," and a nearly identical number (19.4%) answered that they knew someone who had a serious reaction to a vaccination. Such beliefs seemed

to not guide too many respondents, though; 86.3% answered "yes," they "trust their healthcare provider to tell (them) about the risks and benefits of vaccination."

Regardless of high rates of response in favor of vaccination, respondents seemed to be somewhat unwilling to commit to vaccinating themselves. 52.4% of respondents answered yes or maybe when asked if they would refuse a vaccination, with 21.3% responding yes and 31.1% responding maybe. When asked a follow-up question to indicate one reason why they have or would consider doing so, 44.7% of this group responded they would do so if they believed the vaccine was not necessary, 13.5% if they believed the vaccine was unsafe, 10.4% if they believed the vaccine was not effective, 6.7% due to a negative experience with a previous vaccination, 5.5% if they could not afford the vaccination, another 5.5% if they had read or heard negative media about the vaccination, 4.3% because they knew someone who had a reaction to a vaccination, 4.3% because they were afraid of needles or shots, 2.5% if someone they knew told them the vaccination was not safe, 1.3% because they do not believe in vaccination, and another 1.3% if they believed the vaccine was too new **(See Figure 5.3)**. Interestingly, no respondents indicated they had a religious belief against vaccination.

Similar results were found when respondents were asked if they would ever not vaccinate their child. 41.9% responded yes or maybe, with 6% responding yes and 35.9% responding maybe. When asked a follow-up question why they have or would consider doing so, 37.9% responded they would or would maybe do so if they believed the vaccination was not safe, 27.3% if they felt the vaccine was unnecessary, 9.1% if their child had had a previous reaction to the vaccination, 6.8% if they had heard or read negative media about the vaccination, 6.1% if they believed the vaccine was ineffective,

3% if they knew someone who had a reaction to the vaccine, 2.3% because they do not believe in vaccination, 1.5% someone told them the vaccine was unsafe, 0.6% if their child had an allergy to something in the vaccine, and 2.3% had multiple reasons, (**See Figure 5.4**). 3% did not indicate why they would refuse. Just like the similar question regarding reasons why respondents would refuse a vaccination for themselves, no respondent indicated that they have a religious belief against vaccination.

Figure 5.3. Reasons for Refusing Vaccination for Self

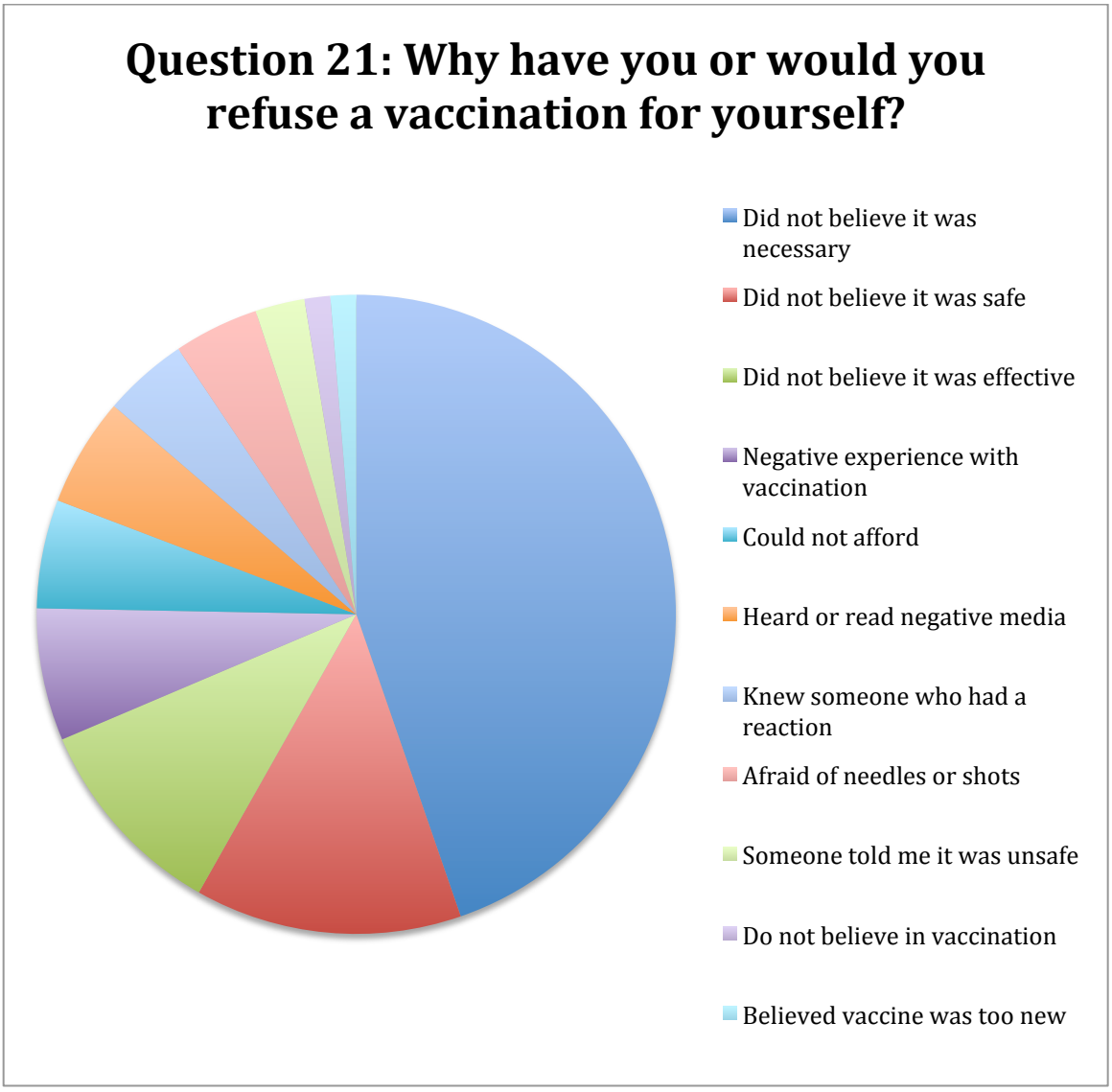
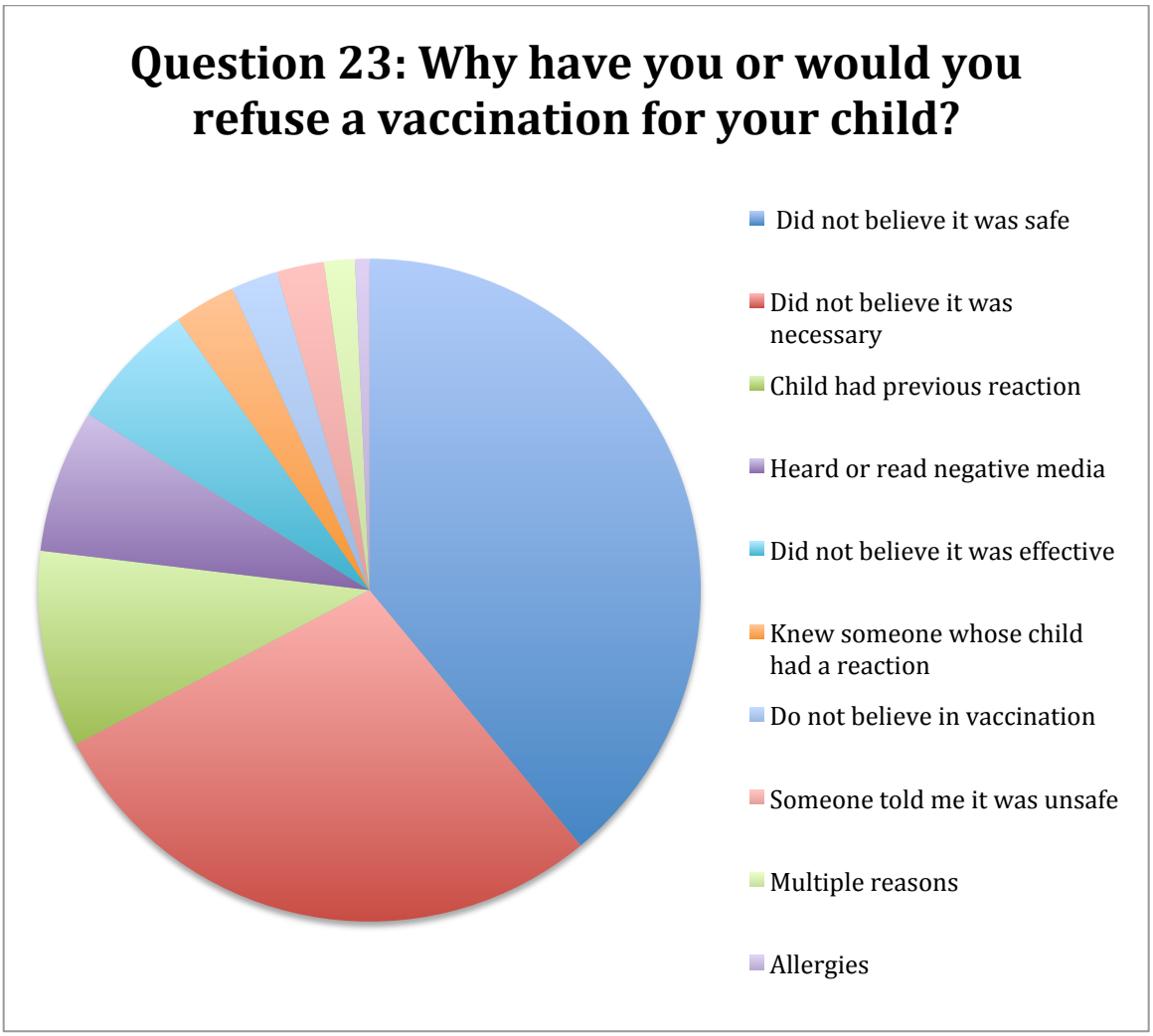


Figure 5.4. Reasons for Refusing Vaccination for Child



General Responses – Second Section

Results for and the text of the second part of questions can be found in the following tables (**See Tables 5.2-5.4**). These questions, comprised of 15 statements ranked on a 5-point Likert scale, asked respondents to rank statements as closely as they matched their individual beliefs. All responses were given a value of 1-5, with "Strongly Disagree" assigned a value of 1 and "Strongly Agree" assigned a value of 5. All mean values for pro-vaccine statements were higher than 3, showing that respondents, on

average, agreed with these statements. All mean values for anti-vaccine statements were lower than 3 except for question 32 (**See Table 5.2, Question 32**), which asked respondents to rank the statement "I am concerned with the side effects of vaccines." This shows that respondents, on average, disagreed with these statements, with the exception of question 32. However, question 32's mean value of 3.03 is so close to the response "neither agree nor disagree" that it does not represent an outlier. It is important to note, however, that a number of respondents seemed uncertain how they felt on several questions—48.9% of respondents neither agreed nor disagreed that newer vaccines are riskier than older ones and 36.4% similarly indicated their unsure beliefs that some vaccines are not safe (See **Table 5.2 Question 28 and Table 5.3 Question 33**).

Table 5.2. Survey Questions Part 2.1

#	Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
24	Childhood vaccinations are important for a child's health	9	7	20	90	189	4.41
25	Childhood vaccinations are effective at keeping children healthy	9	5	21	90	189	4.42
26	Childhood vaccinations are important for the health of the community	7	7	19	81	201	4.47
27	All recommended vaccinations are beneficial	13	35	66	86	115	3.81
28	Newer vaccines are riskier than older ones	38	63	154	38	22	2.82

Table 5.3. Survey Questions Part 2.2

#	Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
29	Getting vaccinations is a good way to protect children from disease	7	7	13	96	190	4.45
30	I trust the information that I am able to receive about vaccines	10	21	41	94	147	4.11
31	I trust my doctor's recommendations regarding vaccines and vaccinations	9	12	24	100	168	4.30
32	I am concerned about the side effects of vaccines	35	90	63	81	44	3.03
33	Some vaccines are not safe	46	69	114	65	19	2.81

Table 5.4. Survey Questions Part 2.3

#	Question	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Mean
34	Children do not need to be vaccinated against diseases that are no longer common (e.g., polio)	141	102	44	22	6	1.89
35	Children receive too many vaccinations	88	118	60	38	11	2.26
36	I trust the media to tell me things about vaccines that my health care provider will not	148	105	44	15	3	1.79
37	I trust groups on the internet to tell me things about vaccines that my health care provider will not	160	93	38	22	2	1.77
38	Vaccines are necessary to keep diseases from spreading	4	16	28	107	160	4.28

Analysis

Chi-squared testing revealed little, if any, relationship between demographic data and respondent answers. Nearly no statistically significant (p-value < 0.05) p-values were found when testing the responses to each demographic question with both sections of questions that made up the remainder of the survey. The single statistically significant relationship between demographic data and survey answers (p-value = 0) exists between major category and how strongly respondents identified with the statement "I trust groups on the internet to tell me things about vaccines that my health care provider will not" (**See Table 5.4 Question 37**). Viewing the response means for each major category reveals that respondents with a major in engineering had a mean of 2.50, while all other major categories had means lower than 2 and the sample mean was 1.78, suggesting that engineering students were more likely to trust internet sources than respondents with majors in other categories.

Testing of respondent answers to the first section of questions (**See Table 5.1**) revealed a staggeringly high number of p-values < 0.05 through both sections of questions. It appears that for each question, those who responded with a pro-vaccine answer gave higher-than-expected rates of pro-vaccine answers to the other questions on the survey, and those who responded to a question with an anti-vaccine answer gave higher-than-expected rates of anti-vaccine answers to other questions on the survey.

In order to produce such results, all questions on the first part of the survey, except for questions 18, 21, and 23, were tested with all questions on the first and second

parts of the survey, except for questions 18, 21, and 23. These three questions were excluded because question 18 asked respondents if they "understand how vaccines work," and questions 21 and 23 were skip-logic dependent on respondents indicating their refusal of a vaccine for themselves or their children in the preceding question (**See Table 5.1**). The results of this analysis were impressive, to say the least: all tested questions were found to have relationships indicated by p-values < 0.05 to nearly every other question on the survey. This suggests that respondents did not hold anti or pro-vaccine beliefs singly in a vacuum. Rather, individuals indicated broad vaccine ideologies that they applied to each of their answers and not just one or two. The following table provides these results (**See Table 5.5**).

Table 5.5. Chi-squared Analysis of Survey Part 1 Responses

Question #	P-value < 0.05 to questions 9-17, 19-20, 22, 24-38?
9	Yes
10	Yes, except 28, 36, and 37
11	Yes, except 28, 36 and 37
12	Yes, except 28 and 36
13	Yes, except 28
14	Yes
15	Yes, except 28
16	Yes, except 28
17	Yes, except 28 and 36
19	Yes, except 28

20	Yes, except 28
22	Yes, except 28

It is apparent when looking at **Tables 5.5** that questions 28, 36, and 37 are exceptions to the web of relationships formed by the questions on both parts of the survey. Question 28, asking respondents if they believed newer vaccines are riskier than older ones, has a distribution of responses concentrated with the response "neither agree nor disagree" and a mean of 2.81 (**See Table 5.2 Question 28**). Because of this, there was a relative lack of respondents indicating pro or anti vaccine beliefs on this question to potentially correlate with responses to other questions.. Questions 36 and 37, which asked respondents if they trusted the media and groups on the internet to tell them things about vaccinations that their health providers would not, had mean values of 1.79 and 1.77, respectively. Such low mean values indicate extremely high rates of "strongly disagree" and "disagree," which is a sign of relatively homogenous beliefs regardless of the respondents' answers to other questions.

Similar results were found when analyzing the 15 belief statements that made up the second set of survey questions ranked on a Likert scale (**See Tables 5.2 – 5.4**). An abundance of p-values < 0.05 appeared to indicate that respondents showing pro-vaccine beliefs on one question would answer with higher –than-expected rates of pro-vaccine responses on the other 14 questions, while anti-vaccine beliefs on one statement was related to higher-than-expected rates of anti-vaccine attitudes on the remainder of questions. Like the analysis done on the first part of the survey, questions 24-38 were tested one-by-one with the other questions. The results were equally striking –

relationships indicated by p-values < 0.05 were found between nearly each pair of questions. These results can be found in the table at the end of this chapter (**See Table 5.6**). Just like analysis of the first set of survey questions, question 28 was an exception to the relationships exhibited by the other questions due to question 28's high level of responses indicating "neither agree nor disagree" and mean value of 2.81.

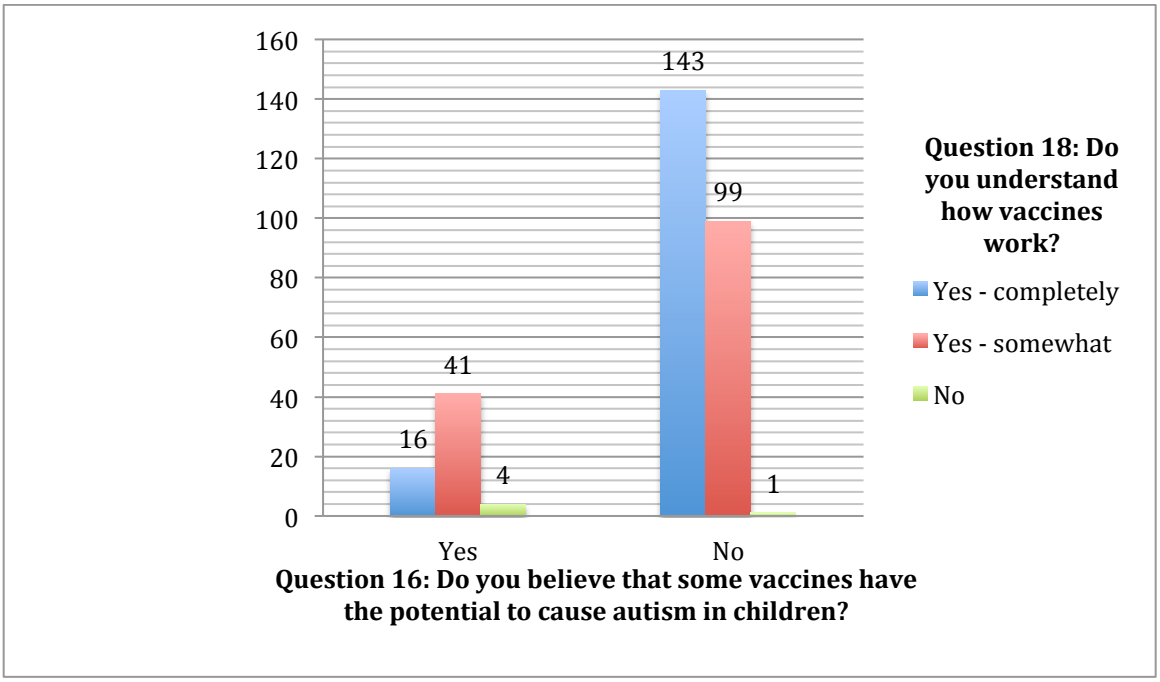
A strong relationship indicated by a p-value of 0.00 was found between questions 18, which asked respondents if they understand how vaccines work, and question 16, which asked respondents if they believed that some vaccines have the potential to cause autism in children (**See Figure 5.5**). This chart shows that after separating respondents into groups based on their responses to question 16, a greater proportion of respondents indicating "yes" indicated lower levels of perceived knowledge of how vaccines work compared to those indicating "no." Those indicating they believed vaccines could cause autism indicated a mean level of perceived understanding of 1.69 compared to a mean of 1.42 by those who do not believe that some vaccines have the potential to cause autism in children. This mean was calculated by assigning a value of 1-3 to each response of "yes – completely," "yes-somewhat," and "no," respectively. Because of this, higher mean values signify lower levels of understanding.

Table 5.6. Chi Squared Analysis of Survey Part 2 Responses

Question #	P-value < 0.05 to questions 24-38?
24	Yes
25	Yes
26	Yes

27	Yes, except 28
28	No, only 24, 25, 32, 33, 34, 35, 38
29	Yes, except 28
30	Yes, except 28
31	Yes, except 28
32	Yes
33	Yes
34	Yes
35	Yes
36	Yes, except 28
37	Yes, except 28
38	Yes

Figure 5.5. Relationship Between Vaccine Understanding and Belief in Vaccine-Autism Link



Chapter VI

Discussion, Recommendations, and Conclusion

Discussion

There are four major findings from the literature review and survey of the University of Mississippi campus. After reviewing the history of vaccine refusal in the United States, it can be concluded that three clearly separate eras of vaccine refusal have informed anti-vaccine beliefs for more than 200 years. In addition, survey results provided valuable insight into the vaccine beliefs held by University of Mississippi students, how anti-vaccine beliefs are held in conjunction with each other, and the value of understanding how vaccines work.

Vaccine-refusal in the United States can be divided into three periods categorized by distinct concerns. The first of such eras occurred at the inception of vaccination in the late 18th century and lasted through the mid 19th century. These misgivings were characterized by uncertainties regarding long-term health effects and safety, a pastoral view of the human body that shunned potential impurities, and the implications that vaccination programs could have on the liberty individuals had to make decisions regarding their own health. The next era began at the end of the 19th century and continued through the beginning of the 20th-century and was characterized by an aversion to the chance for significant and potentially severe side-effects, concerns that mandatory

vaccination laws could be used to infringe upon individual liberties, and skepticism regarding the efficacy of vaccines to prevent outbreaks of certain diseases. The third era began in the middle of the 20th century and has persisted through the present day. These misgivings are characterized by ecological views of health that dismiss vaccination as an unwelcome poison in the human body, prominent media depictions of rare side effects, allegations that certain vaccines and vaccine ingredients have the potential to cause autism, and internet communities dedicated to persuading and assisting parents to refusing vaccinations for their children.

Results from the survey showed that the sample of University of Mississippi students was more pro-vaccine than surveys of the national population. While 84% of national respondents indicated they believe that childhood vaccinations are extremely important and 68% believed all children should be vaccinated, 93% respondents in the survey of students indicated that they believe vaccination is necessary to prevent the spread of disease and 89.5% responded that all children should be vaccinated ("83% Say Measles Vaccine Is Safe For Children," "In U.S., Percentage Saying Vaccines Are Vital Dips Slightly"). When asked whether vaccines can cause autism, 41% of national respondents indicated that vaccines are not a cause, compared to 77.4% of University of Mississippi respondents ("In U.S., Percentage Saying Vaccines Are Vital Dips Slightly"). Very low rates of students indicating media and internet influence when making vaccine-related decisions point to a disinclination of University of Mississippi students to trust vaccine information coming from a source other than their doctors, signaling a lack of influence by the mechanisms of current anti-vaccine movements.

Survey results also indicated strong correlation between anti-vaccine responses to questions on both sections of the survey. Keeping this in mind, it appears that respondents holding one anti-vaccine belief were much more likely to hold others. With respondents exhibiting anti-vaccine beliefs in these clusters rather than individually, the ideological factors that seem to determine vaccine ideology are implicated as broadly anti-vaccine personal philosophies rather than responses to individual vaccine issues.

Finally, is apparent from the survey that vaccine beliefs are influenced by an individual's perceived knowledge of how vaccine's work. 80% of respondents indicating they did not understand how vaccines work and 26.2% of respondents indicating they somewhat understand how vaccines work answered that some vaccines can cause autism, compared with 15% of respondents that said they completely understand how vaccines work.

Recommendations

Based on these survey results, it is apparent that as a whole, the University of Mississippi population has vaccine beliefs that are more supportive of vaccination than the United Sates population as a whole. However, there are opportunities to potentially lower the rate of students who believe vaccines can cause autism and investigate additional demographics of the population for further correlations between certain groups and vaccine beliefs.

With survey results indicating that respondents indicating a correlation between lower levels of perceived knowledge of how vaccines work and a belief that vaccines can

cause autism, an obvious way to combat this is to seek methods of engagement with students in order to help them increase their understanding of how vaccines work. Further research into the curricula of science classes and promotional materials and programs by University Health Promotions is necessary. By doing so, potential deficiencies and opportunities for improvement and program development can be identified.

In addition, further survey research of the vaccine beliefs of University of Mississippi students could potentially benefit from an expanded section on respondent demographics. With a lack of correlation between demographic categories like gender, academic classification, academic program, and state of residence and increased levels of anti-vaccine beliefs, other categories such as race, family income, political affiliation, and county of residence offer further opportunities to investigate such links.

Going forward, policy makers face a growing number of issues requiring their attention. With the internet serving as the most visible platform used by anti-vaccination activists, the risk these websites pose must be evaluated in order to determine how such misinformation can be countered, whether through regulation or aggressive response. In addition, a greater allocation of resources for education programs targeting children, parents, and health care providers must be secured. This is necessary in order to ensure all stakeholders understand the importance of childhood vaccination, especially how vaccination works, its infinitesimal risks, and the role it plays in the health of not only individuals, but entire communities.

Conclusion

As opponents of vaccination turn to the internet to strengthen their cause against immunization, public health officials across the country are faced with the unprecedented task of deflecting attacks on the safety and efficacy of vaccination while contending with outbreaks the diseases that these same vaccines prevent. The results of this study that while some communities like the University of Mississippi have resisted these efforts to turn popular opinion against vaccination, other places have not fared so well, as evidenced by dropping vaccination rates and the resurgence of diseases like whooping cough. With so many places exhibiting effects of the evolving anti-vaccine movement, the greatest potential to prevent a further drop-off in vaccination rates is to challenge exemption laws that allow children to go unvaccinated. The opponents of vaccination may be effective, but as history has proven, the power of government compulsion is stronger. Without stronger vaccination laws in places that allow for ideological vaccine exemptions, vaccination's foes will continue finding success in convincing others to forego the immunization of their children and put the wellbeing of the country at risk.

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