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Honors Program Thesis

An Injection of Truth: An Exploration of Public Health Inequalities Concerning Vaccinations During Outbreaks

Abstract

The inequalities in vaccine uptake can lead to outbreaks that further exploit the differences in health. Public health initiatives in the United States attempt to provide better vaccination coverage and awareness in response, but fail to reflect all inequalities. Public health inequalities are brought about as a result of various policies, differing socioeconomic status, and location. These inequalities affect populations in their own unique ways based on the interaction of their confounding lifestyle factors such as age, class, and accessibility to health sources.

Keywords

Biology, vaccines, disparities, socioeconomic status, public health, inequalities, United States, measles, mumps, influenza, exemptions, Vaccines for Children, A J Wakefield, Jenny McCarthy, accessibility, low income

An Injection of Truth: An Exploration of Public Health Inequalities Concerning Vaccinations During Outbreaks

The ability to prevent and possibly stop certain diseases is just at the tip of the scientific world's fingertips, in the form of vaccinations. Despite the resources available, there are several reasons why vaccination coverage is not more widespread and equally distributed in the United States of America. Those within a lower socioeconomic class are at a higher risk of not being vaccinated than those within a higher socioeconomic class. Monetary difficulties trigger downstream factors that limit transportation, insurance coverage and availability. Religion also plays a role in whether a person is vaccinated, being an acceptable element of exemption in most states. An individual may not wish to vaccinate their child due to fear and the miscommunication of information. Contradictory scientific studies of the past still haunt the American population of today. These disparities can lead to outbreaks, as that portion of the population whose accessibility to vaccinations is lowered would be more susceptible to the illness. The inequalities in vaccine uptake can lead to outbreaks that further exploit these differences in public health. Public health initiatives in the United States attempt to provide better vaccination coverage and awareness in response. The federal government has established programs to provide vaccinations to low-income families, but these initiatives still do not address all of the disparities.

Vaccinations are powerful and elicit a strong response from an individual's adaptive immune system. Vaccines are efficient because they shorten the amount of time that a human's body needs to elicit an immune response (U.S Department of Health and Human Services). The live, attenuated strain of the illness enters the human body, alerting the immune response to act. Since this version of the illness is not pathogenic, the body will be able to create a counterattack

without interference. Macrophages, a type of white blood cell, engulf the foreign strain. This process initiates main downstream immune responses such as swelling and inflammation. Eventually the specific strain's antigens, the unique identifier that antibodies use to target the strain if it were to enter the body again, convert T and B cells into memory cells. Antibodies that recognize and will target the specific antigen of the disease strain are stored in the body for future protection (U.S Department of Health and Human Services). If a second contact with this strain were to occur, the adaptive immune response will take considerably less time and would be able to mount its counterattack against the strain with signaling antibodies it already has rather than having to scramble to create new ones. This priming of the body is what vaccines are made to do.

This method of medicine has lowered the rates of morbidity due to many diseases such as smallpox, measles, influenza, and pertussis (Ventola 2016). However, vaccination coverage is still considered an issue by the American Public Health Association. The lack of education is only one factor that is limiting the access of vaccinations to Americans and in order to eliminate this public health issue, an all-encompassing understanding of the different sides to these factors is imperative.

Vaccinations can sometimes carry a stigma that sways people to not be in favor of them. The fear of vaccinations stems from those believing that the vaccinations themselves are the cause of the disease rather; they are the instruments against illness. One type of vaccination consists of a live, attenuated strain of the microbe. Live, attenuated strains are commonly used in measles, mumps and chickenpox vaccinations. The strain of illness had been modified in a laboratory so that it does not cause the disease within the individual it is being injected into (U.S Department of Health and Human Services). Another common misconception about vaccinations

is that not only do they cause the disease, but also may harm those that receiving them with a severe unknown side effect or reaction. To counter these claims, it has been calculated that there is only a 1 in 1,000,000 chance of an individual having a sever reaction to a vaccine (American Public Health Association 2017).

Resources such as time, transportation and money are a necessity when assessing an individual's probability of receiving a vaccination. Those within a lower socioeconomic class may not have the same resources offered to them as those with a higher income. Accessibility is a factor that several studies have tried to evaluate and determine a plan of action to increase. A study done by Luz *et al.* wished to determine what factors about an individual's life attributed to their perceived risk of not receiving their vaccinations. Focusing on the uptake of the influenza vaccination, the research team issued a survey that inquired about the individual's reasons for refusing to or accepting a vaccination for influenza. Since the influenza vaccine is issued on a voluntary basis, as in it is not mandated to receive, the data would accurately reflect an individual's reasoning. Those that participated in the study were 18 years and older. The questionnaire proposed scenarios that the research team thought may increase vaccination uptake, such as asking if the participant would be more likely to receive their influenza vaccination if it were offered in their workplace or at a location closer to their household. The results of the questionnaire indicated three main reasons individuals did not receive vaccinations: inconvenience, time, and side effects (Lutz *et al.* 2017). These reasons align with the barriers faced by many within a lower socioeconomic class.

The inconvenience of having to take time out of an already tight schedule to receive a vaccination is not considered to be a high priority within some low-income families (Quinn *et al.* 2011). Low-income families value each paycheck they receive, needing every penny of that

money to pay their bills, support their children and buy groceries for the home. Adults tend to have lower vaccination rates than infants and adolescences (Ventola 2016). Adults do not have the same insurance or federally funded plans that cover vaccinations than children do, leading to a lower adherence to vaccination with older age groups (Center for Disease Control and Prevention 2013).

In another research-based survey, Galarce *et al*. linked the factors described in the Lutz *et al.* study and included age and education as other means of lowering the vaccination rate. This study looked at the rates of individuals receiving the A(H1N1) vaccine, most commonly portrayed in the media as a vaccine against swine flu. Swine flu had been the center of a pandemic in 2009, affecting many individuals and even taking lives (Center for Disease Control and Prevention 2010). Despite this, there were still barriers that people needed to overcome in order to receive their vaccinations. Those between the ages of 30 and 44 years old as well as those that only had a high school education were among the groups with the lowest vaccination rates. The reasoning behind this was found in their survey answers regarding the safety of the vaccination, “those with a bachelor's or higher degree were 69% more likely to perceive the vaccine as safe than those with less than a high school degree” (Galarce *et al*. 2011, p. 5286). The fear of side effects from vaccinations stemmed from the lack of education and misinformation that creates a psychological barrier against vaccinations on top of an existing economical barrier.

The inequalities and disparities between vaccination rates are also a result of differences in accessibility between ethnicities. Within the Galarce *et al*. study, Black Americans were the least likely to receive their vaccinations. Their ideologies were similar to that of those that only had a high school education, looking into the side effects of the vaccination. Another factor is

marketing. If vaccinations are not pushed heavily on a certain demographic, then the rate of vaccination is lowered. Vaccination advocacy and advertisement may also contribute to the lowest vaccination rates within adults, as children are usually the prime emphasis of vaccination coverage (Ventola 2016).

Risk of exposure and susceptibility to disease prevented by vaccination is not equally distributed among different ethnicities and socioeconomic classes. The lack of access to healthcare increases an individual's risk of contracting an illness such as influenza of mumps. Quinn *et al.* wished to quantify this data by collecting information in the form of a survey from over 60,000 households. The survey inquired about the demographics, socioeconomic status, and insurance coverage of these families in relation to their influenza vaccination history. According to the research team's findings only 69.5% of people within a low socioeconomic class within the study had access to health insurance. However, 93.5% of those within a high socioeconomic status had access to health insurance (Quinn *et al.* 2011). This difference in numbers is significant and accounts for the lack of vaccinations among those with a low-income. Ethnicity also accounted for the variation in vaccination rates, as "43.6% of Spanish-speaking Hispanics responded that lack of money or insurance would make it difficult for them to get a flu shot, compared with 23% of Whites, 23.3% of Blacks, and 24.2% of English-speaking Hispanics ($P \leq .001$)" (Quinn *et al.* 2011, p. 289). Spanish-speaking Hispanics were overall at the highest risk within this study to not receive their vaccinations. Without health insurance, prices become a barrier to receiving vaccines. However, even with health insurance the fees, despite lessened, can still become an issue. On top of that, distance between centers that offer vaccinations and the time needed to receive them weigh in heavily against the protective act. These inequalities and disparities act on each other, piling on to create this cycle of lower vaccination rates, which leads

to a greater sick of susceptibility to the illnesses that vaccines could easily prime and protect against.

Accessibility of vaccinations due to unequal distribution of them is yet another inequality within America that contributes to lowered vaccination rates. A case study following the distribution of H1N1 vaccines in Los Angeles, California in 2009 brings the inequalities due to socioeconomic status as well as location, discussed earlier, together. In 2009, California had received 839,900 vaccines to fight the spreading pandemic. Upon arriving at Los Angeles, later reports revealed that there had been an unequal distribution of these vaccinations. South Los Angeles County had received one dose to every five people, while West Los Angeles County, which included Malibu, Santa Monica, and Beverly Hills, had received one dose to every two people (Lee *et al.* 2012). Using this case study as a basis, Lee *et al.* created computer simulations of disease outbreaks and distributed vaccinations in a variety of ways to see if the outbreak would be changed in response to it. The research team created their simulation by selecting three low-income counties (Prince George's, District of Columbia and Baltimore City) and three high-income counties (Fairfax, Montgomery, and Loudoun) within metropolitan areas. The simulations had 7,414,562 virtual people that they created using information from the US census. The virtual people had behaviors and moved just as those within an actual pandemic would.

One of the simulation tests involved had a limited number of vaccinations and distributed them to either solely the low-income counties or solely the high-income counties. The results showed that there were fewer total infections as well as fewer new daily infections when the vaccines were given strictly to the low-income counties. When the vaccinations were only given to the high-income counties, the infection rates were the highest, especially at the peak of the epidemic (Lee *et al.* 2012). Through the simulation, economic consequences were also

monitored. In the scenario with only 400,000 vaccines available to be allocated, they were distributed either to the two lowest or the two higher income counties. The higher income counties had almost $24 million more in productivity losses when they received all of the vaccinations than when they were given to the lower-income counties. To further support this scenario, another test divided 700,000 vaccines between either the three lower or higher counties. The productivity loss was $12 million more in the higher income counties than the lower income counties (Lee *et al.* 2012).

The results of the Lee *et al.* study contradict with what had occurred during the H1N1 outbreak of 2009 in Los Angeles. Although this was merely a computer simulation, it provides evidence for allotting more resources to lower income areas. The South Los Angeles County received considerably less vaccines than the West Los Angeles County. If the distribution had either been more even or favored the lower income areas, then the outbreak may have been more contained. The reasons for the higher chance of spreading relate back to the lower socioeconomic status of the counties. Lower income areas are more densely populated. There is also a higher probability that individuals will opt to take public transportation. They may also be unable to get to or have the time to go to the higher income counties in order to receive the H1N1 vaccination. All of these factors will allow a disease such as influenza to spread more rapidly than if an individual was in a less populated area or driving, such as in the higher income counties. This outbreak may have had a lessened impact on both the high and lower income areas of Los Angeles had it not been for the unequal distribution of disease. This inequality was based on the socioeconomic status of the area rather than the population size, limiting the accessibility of vaccinations to those that needed them.

The uptake of human papillomavirus (HPV) vaccine, like the influenza vaccine, is affected by racial disparities. HPV is a common sexually transmitted disease and a known cause of cervical cancer (Cologrove, 2007). By taking the vaccine, women can prevent infection from common HPV strains and reduce the risk of getting cervical cancer from the virus. HPV effects almost 25% of girls aged 14-19, and has a higher prevalence within minority and low-income groups of women (Dunne, 2007). The mortality rate for cervical cancer from HPV was higher in Latina and African American women than in white women. On June 8, 2006 the U.S. Food and Drug Administration licensed the vaccine. At the time, the HPV vaccine targeted young females, 11 to 12 years in age. This vaccine, like other vaccines, was a medical breakthrough of the time. However, the initial price was projected to be around $360 for the full course of three doses of the vaccine (Cologrove, 2007). Those that lacked medical insurance were at a disadvantage with that high set price, which was the main demographic of those affected by HPV and later cervical cancer. Today the cost is even greater. One dose of the HPV vaccine can cost up to $240 (Planned Parenthood, 2018). Medicare does cover the cost fully for women 20 years and under, as well as the Vaccines for Children program for those under 18 years old. However, the options are limited for women not found within these age groups or the specific monetary brackets. While other options still exist to help cover some of the vaccine's cost, they vary per state and take up time and resources that those within a lower income cannot afford.

A study through the Boston Medical Center researched rates of HPV vaccinations, comparing racial disparities and the likelihood of a certain group completing their three dose treatment. The sample size consisted of 7702 girls, 11-21 years old, ranging in racial identity and SES status. Each girl had begun her HPV treatment within the start of the year of the study and was monitored into the following year with the expectation of completing the three doses. The

data from the study found that only half of the girls received all three doses, and a large portion of them were received late (Perkins, 2012). Only 20% of girls within the low-income and minority groups had completed the three doses of the HPV vaccine. These findings relate to nationally recorded vaccination rates of the HPV vaccine being less in low-income patients. While HPV is a sexually transmitted disease and spreads in a different manner than influenza, the racial disparities within vaccine uptake signify its importance. HPV is becoming less of a threat with the vaccine but is unequally available to everyone due to its high price. Other factors found in the study that had been limiting its uptake include education and advertisement (Perkins, 2012). Doctors are not comfortable taking with young girls about their sexuality and therefore do not advertise the vaccination availability or stress its importance. These disparities continue to stack, which can lead to HPV becoming a more widespread problem as it already is.

While vaccinations are most often mandated for students to receive in order to be admitted into public schools, there are three types of exemptions that are accepted: medical, religious, and philosophical (ProCon, 2016). Medical exemptions are for students that have a medical reason as to why they cannot receive the vaccination. A doctor's signature and affirmation of this medical condition is needed to prove this exemption. All 50 states and Washington D.C. accept this exemption. Religious exemptions are for those that cannot receive the vaccination due to their religious beliefs. They believe that the vaccination is not within their religious beliefs and therefore, cannot receive it. The parents of the child would have to sign a waiver, confirming that they understand the risks that their child is under by not being vaccinated. Also, if there were to ever be an outbreak of any of the vaccinated diseases that unvaccinated child must be removed from school until otherwise noted in order to protect them from exposure as well as spreading the disease. Due to laws that protect an individual's religious

beliefs, this exemption is accepted in 47 states and Washington D.C. A philosophical exemption is given to those that do not wish to have their children vaccinated out of their own principle beliefs. These beliefs may be religious, spiritual or strictly personal. They may believe that vaccinations may cause harm to their child, bringing about a strong hesitancy against them. Due to the loose nature of this exemption, only 17 states and Washington D.C. will accept a philosophical exemption. The policies to regulate this exemption are similar for that of a philosophical exemption, but they do vary per state in terms of additional materials aside from a parental signature and awareness of their child's susceptibility. These exemptions create an unequal dispersion of susceptible children within the American school systems. These exemptions leave unvaccinated children open to contracting the diseases and perhaps having them mutate to be able to affect the children that have been vaccinated. On top of this, the unvaccinated children are now able to spread disease and create an outbreak.

In Ohio from March to September of 2014, there was a measles outbreak in an unvaccinated Amish community. Ohio is one of the few states that accepts a medical, religious and philosophical exemption for receiving vaccinations. This Amish community had strong philosophical beliefs against vaccinations. The outbreak began with two Amish men from the community. They had been traveling from the Philippines, where coincidently an outbreak of the measles had just been reported. These two men were not vaccinated and had not been medically examined before their trip back to Ohio (Gastañaduy 2016). Measles is easily transmittable and highly contagious. It can live within the air for up to two hours and is spread through the coughs and sneezes of those that are infected (Center for Disease Control and Prevention 2017). The measles outbreak lasted 121 days and affected 383 people in Ohio. Out of the infected group, 380 were Amish but the other 3 individuals were linked to the same virus that had come from the

Amish community. Out of the Amish community affected by the outbreak, 89% were not vaccinated. As per public health protocol, 106 of the affected were given a MMR vaccine.

Within the state of Ohio, "vaccination coverage with at least one dose or at least two doses of MMR among young children and adolescents was 95.6% and 88.2%, respectively" (Gastañaduy 2016, p. 1346). This outbreak was unfortunate and may have been prevented if vaccinations were received and more widely accepted within the community. This case study highlights a factor that continues to make vaccination coverage a public health issue by the American Public Health Association. Religious and philosophical exemptions provide holes in coverage plans. Despite Ohio having a high percentage of young children and adolescents receiving their MMR vaccine, only 14% of Ohio's Amish community, which includes children, adolescents and adults, has not received the MMR vaccine. During the outbreak, 53% of those affected were between the ages of 5 and 17 years old (Gastañaduy 2016). These gaps and unequal vaccination coverage are the foundations for outbreaks such as the one in the Amish community to spread. This outbreak was contained as soon as it was reported through the hospitals where the affected sought medical care. However, three outsiders of the Amish community contracted the measles from this outbreak. The outbreak did not spread beyond these three non-Amish people, however there was always the potential for it. Those that are not vaccinated due to the lack of health insurance coverage or resource accessibility, i.e. time, transportation, etc., are at a higher disease risk due to those that simply choose to not be vaccinated from personal beliefs. It is an exploitation of the existing inequalities that limit vaccination coverage of those based on socioeconomic status. In response to this outbreak, local health departments within Ohio have been promoting and offering vaccinations to hopefully raise

coverage rates within these Amish communities (Gastañaduy 2016). This outbreak serves as a reminder of the susceptibility of a person who is not vaccinated to these preventable illnesses.

The outbreak in Ohio is one of many examples of outbreaks that arise due to religious or philosophical exemptions from vaccinations. Another outbreak occurred in San Diego, California that spread from a 7-year-old boy who had just returned from a trip to Switzerland. He had not known he had contracted measles until he returned to the United States. The boy was intentionally unvaccinated by his parents. California is one of the few states that only accepts medical exemptions, however this discrepancy may be due to a school policy that was not in conjunction with the state. This adds to the growing inequalities that broaden the lack of vaccination coverage. This one child ended up exposing 839 people, 11 new cases of measles arose in other unvaccinated children (Sugerman *et al.* 2010). Within this outbreak, children that were too young to receive the MMR vaccine, less than 12 months old for the first dose, were also infected. A child that young is at a higher mortality risk than the older children exposed. This is just one of the dangers of not adhering to vaccination regulations. The total cost of containing this outbreak, paid by health care facilities, families and public health officials was $176, 980 (Siddiqui *et al.* 2013). This money was misplaced, being spent on a problem that could have been preventable if the initial patient had been vaccinated. On average, each family affected by this outbreak paid around $775 per child that contracted the measles (Sugerman *et al.* 2010). This cost is absurdly high and was unpredictable to the families affected. These costs would be detrimental to a low-income family. High medical costs and lack of health insurance are common in families of lower socioeconomic status. The measles vaccine, unlike the influenza vaccine, is a part of the mandated list of vaccinations a child is to keep up with in order to enter school. While the rates of children within America who have received the MMR vaccine are

considerably higher than those that have received the influenza vaccine, large disparities exist within nationwide statistics as proven by these outbreaks caused by individuals who have intentionally refused proper vaccinations.

Vaccine hesitancy is a growing problem faced by the American Association of Public Health. There are many misconceptions about vaccinations that still weigh down an individual's decision when they are deciding whether to vaccinate themselves or their children. However, these fears are not misplaced, as science was once a strong antagonist against vaccinations (Poland *et al.* 2009). In 1998, Dr. Wakefield *et al.* published a study in the Lancelet that proposed a link between neuropsychiatric dysfunction with the measles, mumps and rubella (MMR) vaccine. While the study itself did not directly say that the MMR vaccine was linked with autism as well as other behavioral disorders in children, Wakefield was adamant about the causation in press releases on the study (Wakefield *et al.* 1998). The experiment was retracted and the study was found to be falsified. The study only contained a sample size of twelve children, with no control subject. The study attributed symptoms of the children to having occurred after they had received their MMR vaccine, with little other options. Despite this study having a weak scientific foundation and having been retracted from the academic community, the seeds have been planted in the minds of many that vaccines, specifically the MMR vaccine, are dangerous. Vaccine hesitancy existed well before this study, however now those against vaccinations had more fuel to feed their antagonistic opinions. The anti-vaccine movement, those within it known as "anti-vaxers", will continuously bring up the Wakefield study to make up their beliefs and exemptions despite it being scientifically disproven. This leads to more people choosing to become exempt from vaccinations when they are able and healthy to receive them. Once again, the gaps in vaccination coverage will only increase the individual's risk of

contracting the disease. Downstream events will bring negative consequences to those of a lower socioeconomic status that could not afford the vaccinations initially.

The anti-vaccine movement has many powerful members within its group. Jenny McCarthy is an American actress and has been cast in a variety of television shows and movies. She was a co-host on the popular talk show *The View* from September of 2013 to July of 2014. She has an influence due to her image as a well-known celebrity and she uses this as a member of the anti-vaccine movement. Jenny McCarthy is one of the many people that people that believe vaccines are linked to autism. Her son, Evan, was diagnosed with autism in 2005. She claims that he never had seizures before taking the MMR vaccine, immediately linking the two individual events (Frontline, 2015). McCarthy has written several books on her opinions and beliefs that vaccines contributed to her son's autism such as *Louder than Words: A Mother's Journey in Healing Autism (2007), Mother Warriors: A Nation of Parents Healing Autism Against All Odds* (2008), and *Healing and Preventing Autism* (2009).

McCarthy is a prominent activist and spokesperson for the non-profit organization, Generation Rescue. The organization supports the same ideals as McCarthy and also claiming that autism may have environmental and external causes (Charity Navigator, 2017). The main topic of their concern is vaccines. They promote parents to either delay their child's vaccinations as well as not allow them to receive ones that the organization as deemed "unnecessary" such as the chickenpox shot (Frontline, 2015).

In an interview with Jenny McCarthy, she was asked about her opinions on the risk of viruses for the unvaccinated population. Her response was, "Obviously, if polio came back with a vengeance, I think the unvaccinated children should get a polio vaccine. But until then, I don't see the harm in skipping maybe a chicken pox or delaying hepatitis B" (Frontline, 2015). The

disregard for the necessary resources that are lacking in the unvaccinated population is evident in her response. The claims she makes and the organization that McCarthy sponsors continues to deliberately ignore the fact that there are those that do not have the same privileges. The link between autism and vaccines has been scientifically disproven and any relationship between them has failed to be established. The claims made are not based on science but falsified past statements and fear of a disorder that the medical community does not have all of the answers to. Her position of power and influence may educate people with incorrect information. As previous studies have shown education is a major predictor of influenza vaccine uptake, especially among those of a lower socioeconomic status. A person's biases for themselves and the vaccine are correlated to if they will receive the vaccine (Galarce *et al*. 2011). As McCarthy and the Generation Rescue organization continue to feed their beliefs into the anti-vaccine movement, more and more people may take these statements as fact but it have not been backed up by scientific research. The anti-vaccine movement and the Wakefield et al. study are examples of education that negatively impacts vaccination coverage. In order to counteract these messages, more attention should be paid to providing the correct information as well as providing vaccinations to those that need it.

Reasons for vaccine hesitancy include: mistrusting the government, having an optimistic bias against illnesses, not having access or ability to afford vaccines, and fearing the side effects believed to be associated with vaccines. The lack of public awareness and education is a contributing factor in the leading ideologies that vaccines should not be given to children. A study by Suryadevara *et al.* explored the reasons why low-income individual's refuse or are vaccine hesitant, specifically the influenza vaccination. The study surveyed 1041 people living in central New York that had income of less than 150% of the federal poverty guideline

(Suryadevara *et al.* 2014). The reasons for vaccine hesitancy were mixed. Some had already received their influenza vaccinations and perceived the vaccine to be safe; others either intended on receiving it or refused it. One of the barriers that the low-income individual's faced was limited access to resources such as not having a doctor, no time, no health insurance or no way to access a facility that administers the vaccination. In terms of personal belief, those that refused their influenza vaccinations had a variety of ideologies to support them. More African Americans in the survey sample did not trust the government, and in turn did not wish to accept a vaccination from the government. More males than females had a strong optimistic bias, believing that the vaccination was not necessary, as they would not contract the flu or that they were healthy enough to withstand it (Suryadevara *et al.* 2014). This misplaced optimism and self-confidence is yet another barrier for public health officials to overcome in order to expand vaccination coverage to a wider audience.

There are many obstacles blocking individuals from receiving the vaccinations that can prevent the spread and contracting of diseases as well as lower mortality rates from those diseases. The federal government has been funding the Vaccines for Children (VFC) program since October of 1994 in other to alleviate some of those obstacles. Through VFC, eligible families can have their children vaccinated for free. The plan only covers children up to 18 years of age, contributing to the lower rates of coverage in those 19 years and older. In order to be eligible for VFC, a family must either be underinsured, have no insurance, eligible for Medicaid, or a Native American or Alaskan Native resident (Center for Disease Control and Prevention 2014).

The federally funded plan is not as perfect as it is advertised to be. There are gaps in its vaccination coverage plans that fail to eliminate the problems faced by those within a lower

socioeconomic class. While the VFC program covers the cost of the vaccination, the doctor can still charge the family for the initial visit. A doctor's visit does not solely consist of receiving a vaccination and leaving. A doctor checks vitals, takes a brief history, and must assure that the child is able to receive the vaccination without any compromising effects based off of the past medical history. Therefore, the doctor can charge the family for the visit and anything done other than administering the vaccine. Furthermore, the program does not provide the family with any assistance in accessibility. About 44,000 doctors across America accept VFC funding (Center for Disease Control and Prevention 2014). The families under the VFC program may not be able to reach a doctor within the plan, unable to use its services which leaves their children unvaccinated. The plan is in need of alternations, lending more aid to the low-income families. Another way to improve it would be to expand its influence on other doctors as well as in healthcare clinics and pharmacies that may be more accessible in low-income areas. While there are a myriad of ways to improve the program, its merits should not go unnoticed. The program is a positive start and has been making an impact on children's vaccination coverage. In a study by Walker *et al.*, the team analyzed vaccinations trends of the vaccines covered through VFC from 1995 to 2011. The results proved that that disparity gap between children of different ethnicities was lessening. In vaccination coverage rates of measles, poliovirus, diphtheria, pertussis and tetanus had no disparities in children based off of ethnicity, providing evidence for the remarkable impact of the VFC on low-income families and underrepresented ethnicities (Walker *et al.* 2012).

VFC is not the first federally funded program to enforce free vaccination coverage. In 1813, Congress passed "An Act to Encourage Vaccinations" which shipped smallpox vaccines

without a fee to those that requested it. This particular policy varies greatly from how vaccines are regulated today and the Vaccines for Children program.

Before explaining the federal policy, it is important to note the impact the smallpox had on America during this time period. Smallpox was more prevalent before the eighteenth century, and had a mortality rate that would be the equivalent of 30,000 people a year in modern day populations (Singla, 1998). Prior to the late eighteenth century, a vaccine for smallpox had not been developed. In 1796, Edward Jenner made his first successful vaccine against smallpox (Colgrove, 2007). He postulated that when an individual caught cowpox, there was never any further history of smallpox. Believing that one illness may induce immunity for another, his first vaccine included material from a cowpox lesion from the hand of a milkmaid. He inoculated a young boy with the cowpox material. While the vaccine did induce symptoms of cowpox, lesions and fever, they resolved within several days. When Jenner introduced material from smallpox to the boy's arms, there was no reaction (Colgrove, 2007). This observation led Jenner to conclude is initial belief for his smallpox vaccine. Since then scientific advancements have been made to make the smallpox and further vaccines more effective for the overall population. However the Vaccine Act of 1813 laid a heavy precedent in its concern for the overall health of the population rather than the individual that did not become an area of public concern until almost a century later.

The Vaccine Act of 1813 was repealed nine years after implementation due to a tragic incident. Contamination and the incorrect vaccines, smallpox rather than cowpox, had been shipped and distributed causing several deaths (Colgrove, 2007). However, it is the essence of the policy that makes it important. The Vaccine Act of 1813 placed the power of vaccine distribution within the funds of the government. In the early nineteenth century and with the rise

of the smallpox vaccine, attempts were made to raise money to allocate for vaccinations in the wealthiest states of the Union: Massachusetts, New York, Maryland, Pennsylvania, and North Carolina (Singla, 1998). Each proposal within the states failed to be passed. This was one of the reasons behind the Vaccine Act of 1813's formation. The act established a national fund for vaccination, bringing attention to the health of the population into perspective. Herd immunity or community immunity can only occur if a majority of a population has an immunity for the illness. This is to repress the rapid spreading and outbreak of the illness from person to person within a closed space, a community or herd. The Vaccine Act of 1813 was one of the first federally funded acts that placed the health concerns of the group first (Singla, 1998). Despite its efforts, the policy itself did not have a strong foundation. It was harder to acquire vaccinations in the 1800s. The first smallpox vaccines could only be acquired by taking samples from patients infected up to eight days after being exposed to the pathogen (Singla, 1998). The production could not keep up with the overwhelming demand and mistakes made led to the repeal of this act. However in today's society, it may be possible to implement an act like this again. The act was proposed in a time that lacked the scientific advancements and laboratory technology needed to meet the vaccination demands of the population. The needs of the people were obviously placed to a great degree of importance in order to lower mortality rates of smallpox. Those same ideals should lay the groundwork for further public policy in modern American federal programs. Qualitative research further explains the desire for individuals to have more accessible programs for vaccination coverage, especially for those within a low socioeconomic class.

Initiatives to provide free vaccinations to people within low-income areas have already proven to be a successful promotion towards increasing vaccination coverage. VFC benefits children up to 18 years of age. However, adults are lacking in that same amount of federally

funded coverage. Aside from collecting data on why an individual within a low-income area was hesitant to vaccinations, Suryadevara *et al.* also created a program to fix the accessibility issue mentioned in the results of the study. Every December, local Salvation Army's host gatherings for low-income families and offer them food and gifts. The sample size of the study was collected from the families that had attended this gathering. In addition to participating in the vaccination, the Salvation Armies also provided free influenza vaccinations to anyone eligible. This initiative was the "first report of offering influenza education and on-site IV [influenza vaccines] at a community-based organization gift program known to be accessed by a large number of low-income families" (Suryadevara *et al.* 2014, p. 2100). This is only the beginning of other public health initiatives that can increase the vaccination rates and limit the gap between those of a higher socioeconomic and those of a lower socioeconomic status. Everyone deserves an equal opportunity and accessibility to vaccinations.

Public health inequalities are brought about as a result of various policies, differing socioeconomic status, and location. These inequalities affect populations in their own unique ways based on the interaction of their confounding lifestyle factors such as age, class, and accessibility to health sources. Socioeconomic status is an umbrella term for a multitude of factors that limit an individual's accessibility to vaccinations. Not having access to funds in order to support medical expenditures can lead to even greater costs later in life due to an increased susceptibility to outbreaks. Starting in the mid-1990s, the United States began a federally funded program to protect children from up to 16 different diseases by offering vaccinations free of charge. The attempt to solve a monetary deficiency could only go so far. Lower income families may not have the transportation or time to take their children to a health care facility. However in recent years, more and more options are becoming available where people can receive their

vaccinations. Influenza vaccinations have been offered at pharmacies, supermarkets, grocery stores, college campuses, and places like Salvation Armies that provide resources to families in need. These are small, but effective efforts in increasing vaccination coverage and eliminating the existing inequalities and disparities that effect it.

Education against vaccination hesitancy is another step in the right direction. By promoting vaccinations to a larger audience and working to eradicate the stigma associated with them, rates may also increase. Education should also be focused on spreading awareness of the existing inequalities and disparities. It is too tempting to conclude that it is easy for everyone to receive their proper vaccinations given the federally funded programs available, but that is not enough. Distances exist between where a family lives and where a vaccination is being administered. Communities of people refuse to vaccinate their children because of their philosophical beliefs. The inequalities hinder total vaccination coverage, but with careful planning and continued public health initiatives there can be greater overall coverage no matter how old a person is or the income level of their community.

References

AJ Wakefield, SH Murch, A Anthony, J Linnell, DM Casson, M Malik, M Berelowitz, AP Dhillon, MA Thomson, P Harvey, A Valentine, SE Davies, JA Walker-Smith, RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children, In The Lancet, Volume 351, Issue 9103, 1998, Pages 637-641, ISSN 0140-6736, https://doi.org/10.1016/S0140-6736(97)11096-0.

"About VFC." Centers for Disease Control and Prevention. February 14, 2014. https://www.cdc.gov/vaccines/programs/vfc/about/index.html

"CDC Health Disparities and Inequalities Report — United States, 2013." *Center for Disease Control and Prevention - MMWR* 62, no. 3. doi:10.3897/bdj.4.e7720.figure2f. https://www.cdc.gov/mmwr/pdf/other/su6203.pdf

Centers for Disease Control and Prevention. "Measles Transmission." Centers for Disease Control and Prevention. March 03, 2017. https://www.cdc.gov/measles/about/transmission.html.

Charity Navigator. (n.d.). Generation Rescue. Retrieved from https://www.charitynavigator.org/index.cfm?bay=search.summary&orgid=14711

Dunne, E. F., Unger, E. R., Sternberg, M., Mcquillan, G., Swan, D. C., Patel, S. S., & Markowitz, L. E. (2007). Prevalence of HPV Infection Among Females in the United States. Jama, 297(8), 813. doi:10.1001/jama.297.8.813

Ezequiel M. Galarce, Sara Minsky, K. Viswanath, Socioeconomic status, demographics, beliefs and A(H1N1) vaccine uptake in the United States, In Vaccine, Volume 29, Issue 32, 2011, Pages 5284-5289, ISSN 0264-410X, https://doi.org/10.1016/j.vaccine.2011.05.014.

Frontline. (2015, March 23). Jenny McCarthy: “We’re Not An Anti-Vaccine Movement … We’re Pro-Safe Vaccine”. *PBS - Frontline*. Retrieved from https://www.pbs.org/wgbh/frontline/article/jenny-mccarthy-were-not-an-anti-vaccine-movement-were-pro-safe-vaccine/

Gastañaduy, Paul A., Jeremy Budd, Nicholas Fisher, Susan B. Redd, Jackie Fletcher, Julie Miller, Dwight J. Mcfadden, Jennifer Rota, Paul A. Rota, Carole Hickman, Brian Fowler, Lilith Tatham, Gregory S. Wallace, Sietske De Fijter, Amy Parker Fiebelkorn, and Mary Diorio. "A Measles Outbreak in an Underimmunized Amish Community in Ohio." *New England Journal of Medicine* 375, no. 14 (2016): 1343-354. doi:10.1056/nejmoa1602295.

Lee, B. Y., S. T. Brown, R. R. Bailey, R. K. Zimmerman, M. A. Potter, S. M. Mcglone, P. C. Cooley, J. J. Grefenstette, S. M. Zimmer, W. D. Wheaton, S. C. Quinn, R. E. Voorhees, and D. S. Burke. "The Benefits To All Of Ensuring Equal And Timely Access To Influenza Vaccines In Poor Communities." *Health Affairs* 30, no. 6 (2011): 1141-150. doi:10.1377/hlthaff.2010.0778.

Luz, Paula M., Riley E. Johnson, and Heidi E. Brown. "Workplace availability, risk group and perceived barriers predictive of 2016–17 influenza vaccine uptake in the United States: A cross-sectional study." *Vaccine* 35, no. 43 (2017): 5890-896. doi:10.1016/j.vaccine.2017.08.078.

Perkins, R. B., Brogly, S. B., Adams, W. G., & Freund, K. M. (2012). Correlates of Human Papillomavirus Vaccination Rates in Low-Income, Minority Adolescents: A Multicenter Study. *Journal of Womens Health, 21*(8), 813-820. doi:10.1089/jwh.2011.3364

Planned Parenthood. (n.d.). HPV Vaccine - What Is the HPV Vaccination. Retrieved from https://www.plannedparenthood.org/learn/stds-hiv-safer-sex/hpv/should-i-get-hpv-vaccine

Poland, Gregory A., Robert M. Jacobson, and Inna G. Ovsyannikova. "Trends affecting the future of vaccine development and delivery: The role of demographics, regulatory science, the anti-vaccine movement, and vaccinomics." *Vaccine* 27, no. 25-26 (2009): 3240-244. doi:10.1016/j.vaccine.2009.01.069.

ProCon. "State Vaccination Exemptions for Children Entering Public Schools - Vaccines - ProCon.org." ProConorg Headlines. https://vaccines.procon.org/view.resource.php?resourceID=003597.

Quinn, Sandra Crouse, Supriya Kumar, Vicki S. Freimuth, Donald Musa, Nestor Casteneda-Angarita, and Kelley Kidwell. "Racial Disparities in Exposure, Susceptibility, and Access to Health Care in the US H1N1 Influenza Pandemic." *American Journal of Public Health* 101, no. 2 (2011): 285-93. doi:10.2105/ajph.2009.188029.

Siddiqui, M., Salmon, D. A., & Omer, S. B. (2013). Epidemiology of vaccine hesitancy in the United States. *Human Vaccines & Immunotherapeutics*, *9*(12), 2643–2648. http://doi.org/10.4161/hv.27243

Singla, R. K. (1996). Missed Opportunities: The Vaccine Act of 1813. *Harvard Law School*.

Sugerman, D. E., A. E. Barskey, M. G. Delea, I. R. Ortega-Sanchez, D. Bi, K. J. Ralston, P. A. Rota, K. Waters-Montijo, and C. W. Lebaron. "Measles Outbreak in a Highly Vaccinated Population, San Diego, 2008: Role of the Intentionally Undervaccinated." *Pediatrics* 125, no. 4 (April 22, 2010): 747-55. doi:10.1542/peds.2009-1653.

Suryadevara, Manika, Cynthia A. Bonville, Paula F. Rosenbaum, and Joseph B. Domachowske. "Influenza vaccine hesitancy in a low-income community in central New York State." *Human Vaccines & Immunotherapeutics* 10, no. 7 (2014): 2098-103. doi:10.4161/hv.28803.

"The 2009 H1N1 Pandemic: Summary Highlights, April 2009-April 2010." Centers for Disease Control and Prevention. June 16, 2010. https://www.cdc.gov/h1n1flu/cdcresponse.htm.

U.S. Department of Health and Human Services. "Types of Vaccines." Vaccines.gov. October 11, 2006. https://www.vaccines.gov/basics/types/index.html.

U.S. Department of Health and Human Services. "How Vaccines Work." Vaccines.gov. October 11, 2006. https://www.vaccines.gov/basics/work/index.html.

Ventola, C. Lee. "Immunization in the United States: Recommendations, Barriers, and Measures to Improve Compliance: Part 1: Childhood Vaccinations." *Pharmacy and Therapeutics* 41, no. 7 (2016): 426-436.

Ventola, C. Lee. "Immunization in the United States: Recommendations, Barriers, and Measures to Improve Compliance: Part 2: Adult Vaccinations. " *Pharmacy and Therapeutics* 41, no. 8 (2016): 492-506.

Walker, Allison T., Philip J. Smith, and Maureen Kolasa. "Reduction of Racial/Ethnic Disparities in Vaccination Coverage, 1995–2011." *Morbidity and Mortality Weekly Report* 63, no. 1, 7-12.