FACTORS AFFECTING THE SHINGLES VACCINATION RATE IN SENIORS: THE

SHINGLES (ZOSTAVAX) AND TETANUS VACCINATION COMPARISON

by

Ogulsoltan Arazgeldiyeva

APPROVED BY SUPERVISORY COMMITTEE:

_____

Richard K. Scotch, Chair

_____

Euel W. Elliott

_____

Jennifer S. Holmes

_____

Dohyeong Kim

To every American who fights to make healthcare a basic human right

FACTORS AFFECTING THE SHINGLES VACCINATION RATE IN SENIORS: THE

SHINGLES (ZOSTAVAX) AND TETANUS VACCINATION COMPARISON

by

OGULSOLTAN ARAZGELDIYEVA

DISSERTATION

Presented to the Faculty of

The University of Texas at Dallas

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY IN

PUBLIC POLICY AND POLITICAL ECONOMY

THE UNIVERSITY OF TEXAS AT DALLAS

May 2021

ACKNOWLEDGMENTS

FACTORS AFFECTING THE SHINGLES VACCINATION RATE IN SENIORS: THE

SHINGLES (ZOSTAVAX) AND TETANUS VACCINATION COMPARISON

Ogulsoltan Arazgeldiyeva, PhD
The University of Texas at Dallas, 2021

Supervising Professor: Richard K. Scotch, Chair

Health status, demographics, financial factors, education status, internet literacy of seniors, and

having a usual place for health care may affect the Shingles vaccination rate in seniors. While

activity limitation and being a minority may affect the vaccination rate negatively, having a

chronic condition, being married better financial status, higher education level and internet

literacy may affect the vaccination rate positively. Using different logistics regression methods,

this study analyzes how different factors affect the Shingles vaccination rate in seniors. As first

Shingles vaccine has been around for 13 years, to get more accurate results, this study analyzes

factors affecting Tetanus vaccination rate in seniors as well. This study uses the IPUMS National

Health Interview Survey data from 2009 to 2018. Region, race, sex, education level, being above

or below poverty threshold and being covered by military health insurance had big effect on the

Shingles vaccination rate. Additionally, having had a flu shot in the past 12 months,

communicating with health care provider using email and looking up health information in

Internet had a positive effect. The findings can be used to help pinpoint the reasons of low

Shingles vaccination rate in seniors and address them to improve the vaccination rate.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

In early 2017 several European countries started to experience more than the usual number of Measles cases. While the first group of Measles cases were reported in one region of Greece in 2017, by 2018 all 13 Greek regions and several other European countries were affected. The measles spread from Roman unvaccinated kids aged 6 months, 1 year and 6-year-old (Georgakopoulou, et al., 2018). According to the World Health Organization (WHO), by August 2018 there were 41 thousand reported cases in Europe and 40 deaths. This outbreak, which was unimaginable 5-10 years ago, is the direct result of the unvaccinated or partially vaccinated kids and adults. When the disease, which was almost extinct because of the effective preventative care, reemerged, public health officials looked for ways to increase the vaccination rate of the disease, which can be prevented by effective vaccines. Despite the presence of many anti-vaccination groups in First World countries, vaccination is known to be safe, successful and cost-effective and it has been a key part of the United States health policy.

Anti-vaccination movements go back to the 18th century, when Reverend Edmund Massey in England stated that vaccines were "diabolical operations" (Hussain, et al., 2018, p.8). The movement was regenerated in 1998 when the doctor and researcher from England, Andrew Wakefield, published a paper which suggested a causal connection between the MMR vaccine and autism. The publication was widely criticized by the medical community, and the research was found to be flawed and unethical, as it was found that Andrew Wakefield received funds from opponents of the vaccine manufacturers (Hussain, et al. 2018). Although he was banned

from practicing medicine in the United Kingdom and his research was proven to be inaccurate, the anti-vaccine movement is still active.

Discovered with the help of modern medicine, vaccinations prevent previously serious diseases which have devastating effects. In the absence of vaccinations, the diseases mostly hurt the vulnerable, kids and seniors, as the immune systems of both groups are weak. In the United States, there are several diseases with vaccination rates below the national goal. In this paper, we will look at the problem of low vaccination rates among seniors, especially for Shingles, which is also known as Herpes Zoster (HZ), and for Tetanus.

Although the benefits of vaccination are well known and proven, the rate of major vaccinations for seniors is alarmingly low. While vaccination rates for children have been increasing steadily and have increased to over 90 percent, vaccination rates for seniors have not changed significantly in the last decade. Senior vaccination rates have been almost flat for many years and presently are substantially below the national goal, a minimum rate of 90 percent.

Table 1 summarizes the problem we are facing with senior vaccination rates in the United States. Although Flu vaccine, which is utilized against respiratory infections caused by several strains of viruses, is offered and promoted widely, 31 percent of seniors were not vaccinated against the flu in 2017. It is known that there are about 20,000 deaths in the United States associated with influenza, and seniors are at greater risk than younger adults (Zimmerman et al., 2003). The picture gets worse if we continue to analyze different vaccination rates. Pneumonia vaccination, which is conducted against invasive pneumococcal diseases (IPD), is only received by 63.6 percent of seniors. This is a once in a lifetime vaccination, which should decrease the burden of getting it. It is known that the risk of seniors getting IPD is three times more than the

risk for younger adults aged 19-64 (Chan et al., 2015). Despite the fact that vaccination is covered under Medicare, it remains underused by seniors (Jones et al., 2010). Similarly, Tetanus shots are conducted against Tetanus, also known as "lockjaw", which is a bacterial infection that damages the nervous system. According to the federal Centers for Disease Control and Prevention (CDC), 15 percent of people with Tetanus die from its complications. Despite the serious nature of this disease, 43.1 percent of seniors are not vaccinated against it.

Table 1: Main Vaccination Rates for Seniors
Source: Center for Disease Control and Prevention (CDC, 2017)

Name of Vaccination	Seniors Vaccinated (%)
Flu	69
Pneumonia	63.6
Tetanus	56.9
Shingles	34.2*

The most problematic vaccination rate is for the Shingles virus. Only 34.2 percent of seniors are vaccinated against Shingles, a viral infection caused by the reactivation of the varicella zoster virus, which also is known as the chickenpox virus. Among these four problematic vaccinations, Influenza and Pneumonia vaccinations are covered by Medicare Part B, while Tetanus and Shingles vaccinations are covered only by Medicare Part D for prescription medication, an optional coverage only some seniors purchase.

Seniors who are willing to get flu shots and Pneumonia vaccinations do not pay anything out of their pockets as both are covered under Medicare Part B. Tetanus and Shingles vaccinations, on the other hand, only are covered under Medicare Part D, and if a senior does not

have this additional insurance, he/she pays a portion of the cost out of pocket. For Tetanus shots, the out-of-pocket cost can range between $25 and $75, while for Shingles vaccine it is between $25 and $195 for Zostavax and even more for the Shingrix vaccine. Additionally, Influenza, Pneumonia and Tetanus shots are widely available in physicians' offices, pharmacies and health clinics, which is not the case for Shingles vaccine.

1.1 Tetanus

According to the information on the CDC website, Tetanus is an infectious disease caused by a bacterium called Clostridium Tetani. The bacterium can live in manure treated soil, dust and feces of some animals. Clostridium Tetani enters the body through the injury site and produces a poison which causes severe muscle contractions. Depending on the location of the injury site, the incubation period of the bacterium is between three to 21 days. If the injury site is located close to the central nervous system, the incubation time is shorter than the average of eight days. The shorter incubation period means higher chance of death. With the development of vaccination, Tetanus has become a very rare but still deadly disease. The risk of getting a Tetanus is higher in seniors, people with diabetes and people who use injection medications.

There are three forms of Tetanus: localized, cephalic and generalized Tetanus. Cephalic Tetanus is the rarest form of the disease and is linked with the wounds of the head, face or the inflammatory diseases of the middle ear called otitis media. While localized and generalized Tetanus cases show muscle spasms, cephalic Tetanus causes loose cranial nerve palsies. This type of Tetanus, as well as localized Tetanus, can progress to the generalized form of the disease. Localized Tetanus, which is unusual, is considered a mild form of the disease as only 1% of the

cases is fatal (CDC). The constant muscle contractions occur in the area of the injury site, and can last for many weeks before slowly diminishing or in some cases, turning to a generalized form of the Tetanus. The third form of the disease is called a generalized Tetanus and is seen in 80% of the cases. The most common sign of generalized Tetanus is spasm of the jaw muscles, which is the reason of the alternative name of the disease - "lockjaw". This form was fatal in 11% of the reported cases and most of the fatal cases are reported to be people over 60 years of age.

According to the CDC, there were 197 reported cases of Tetanus between 2009 and 2015, and 16 of these cases resulted in death. People 65 years of age and older constitute 25% (49 cases) of the cases while 63% (124 cases) of the cases were seen in people aged between 20 and 64. The smallest portion of the cases, 12% (24 cases), belongs to people younger than 20. The alarming fact is that all 16 deaths cases were seen in people aged 55 or older (Figure 1).

While there are only two death cases in the 50-59 and 60-69 age groups combined, the number increases to three in 70-79 age group and peaks in the 80 and older age group with 11 death cases out of 23 reported Tetanus cases for that age group. As the age increases and the immunity of the person decreases, it becomes harder for the human body to fight against the diseases. This is the case with Tetanus as well. Only in 10 out of 197 cases was the patient fully vaccinated with three doses of Tetanus vaccination, and others were either unvaccinated or vaccinated with fewer than three doses.
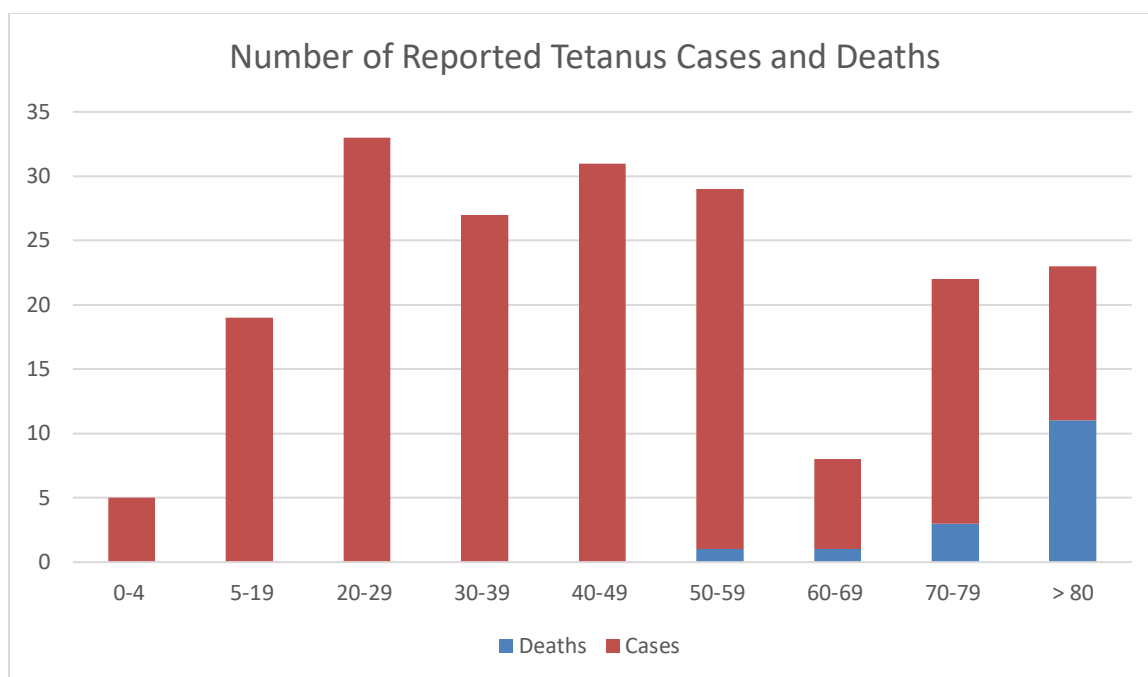
Figure 1: The Number of Reported Tetanus Cases and Deaths Between 2009-2015
Source: Manual for the Surveillance of Vaccine-Preventable Diseases. Center for Disease
Control and Prevention (CDC, 2017)

Although Tetanus is a rare occurring disease, with about 30 reported cases each year in the

United States, when caught, the probability of hospitalization is 100%. The average number of

hospitalization days is 16.7, one of the highest ones among 12 other vaccine preventable

diseases. As a result, the cost per hospitalization was calculated as $102,584 in 2013 US dollars.

The cost for each outpatient visit was calculated as $100 (Whitney et al., 2014). Additional to a

long treatment, hospitalization time and high case fatality rate, the cost of the disease is very high

considering that the vaccine costs $54.99 per dose, as of March 2019, and is covered by most

insurance plans including Medicare part D. By increasing the Tetanus vaccination rate among

the senior population, we could decrease the number of deaths caused by the disease. As shown

in Figure 1, almost 94% of the deaths occurred in 60 year and older age groups.

1.2 Shingles

 Shingles is a painful skin rash with water-filled blisters which is caused by the reactivation of the chickenpox virus. The virus, which is called Varicella Zoster Virus (VZV), first causes chickenpox and then becomes inactive until the immunity of the person declines. It can appear in any part of the body but particularly appears in the chest and lower spinal area. As age increases, the severity and complications of the disease also increase because of natural decline in cell-mediate d immunity (CMI). It is estimated that 98 percent of the American population has had chickenpox, which means that they are carrying VZV that can cause Shingles (also called as herpes zoster). In their 2015 report, the Alliance for Aging Research states that 50 percent of people who live up to age 85 will get Shingles in their lifetime, while other researchers estimate the lifetime risk to be 30 percent (Mahamud et al., 2012; Jumaan et al., 2002). It is estimated that Shingles affects close to one million people per year in the United States (Quan et al., 2007).

  Shingles consists of three clinical phases. Between 70-80% of the Shingles cases are in the prodromic phase which starts several days before the rash starts to appear. The symptoms of this phase are not specific but can include itchy and burning skin, fever, fatigue and headache. The next phase is called an acute phase. It is associated with skin rashes accompanied by fluid filled blisters called vesicles. As the age of the person increases, the duration of the rash increases too. The disease is contagious during this phase, and contagiousness stops with the crusting of the blisters (Gabutti et al., 2014). The chronic phase begins at least a month after the rash has cleared, and it is associated with postherpetic neuralgia (PHN).

  According to CDC, around 10 percent of the patients who get Shingles will develop PHN, that can lead to severe pain for months or even years. Together with the rate of Shingles,

the rate of PHN increases with age. The rate of Shingles is close to 1 in patients under 30, and this rate is ten times bigger at age 80 and older. While the PHN rate is close to zero when patients are in their 20s and 30s, the rate starts to increase rapidly after the patient turns 50 (Figure 2).

It has been reported that the pain patients have experienced from Shingles is worse than the pain of child labor, osteoarthritis and pain from chronic conditions like chronic cancer. In an interview given to Ophthalmology Times, Thomas Liesegang, MD mentions that stubborn pain caused by Shingles is a big difficulty for patients and is also associated with a high risk of suicide. Pain must be so unbearable that 42% of people with Shingles describe it as "horrible and excruciating" (Groves, 2014). However, Shingles is not associated with pain only; one in ten people who get Shingles rashes on their faces can become blind because of complications.
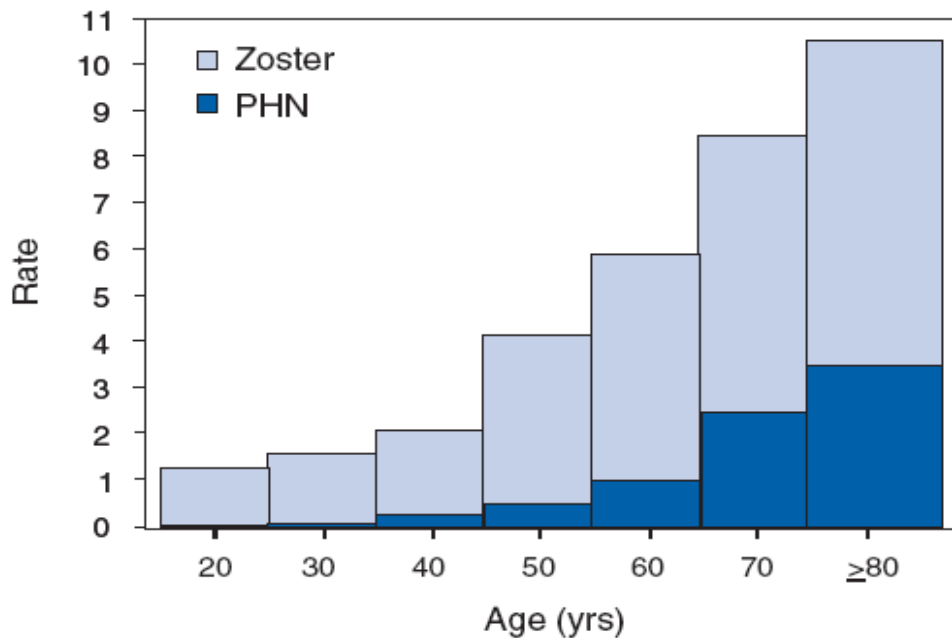
Figure 2: Shingles and PHN rates (per 1,000 person years) by age in the United States
        Source: Shingles Surveillance, Center for Disease Control and Prevention (CDC, 2016)

Among all of the above-mentioned diseases and the vaccinations against them, increasing the Shingles vaccination rate would produce the greatest reduction in financial burden. The Alliance for Aging Research reports that medical cost of Shingles is estimated to be more than one billion dollars per year, which is the result of seniors' 1.3 million doctor visits, 87,000 emergency room visits, 28,000 hospitalizations and 3.3 million prescriptions per year. These numbers do not include the cost of psychological help seniors are getting in the aftermath of a long and painful disease. It is estimated that if we increase the Shingles vaccination rate to 60%, which is way below than the national goal of 90%, the financial cost of Shingles would decrease in large proportions. In their 2020 study, Harvey et al., projected that there are 1.1 million HZ cases among the unvaccinated US population annually. Of these cases, 114,000 experience postherpetic neuralgia (PHN), and in 43,000 cases, Shingles rashes appeared around the eyes and patients were faced with ocular complications. The study projects that the burden of Shingles, which includes direct medical costs and the loss of economic productivity, is $2.4 billion annually. As the shingles vaccination rate is significantly lower than the other vaccination rates for seniors, it is crucial to understand the risk of the disease and benefits of a preventative care.

There are four objectives of this research: (a) to test whether is a correlation between health status of seniors, having a usual place for health care and the Tetanus and Shingles vaccination rate; (b) to test whether there is a correlation between demographics of a senior and the Tetanus and Shingles vaccination rate; (c) to test whether there is a correlation between financial factors and the Tetanus and Shingles vaccination rate; (d) to test whether there is a correlation between

education status, internet literacy with the Tetanus and Shingles vaccination rate. Therefore, this study tests the following four hypotheses within the limits of the available data:

a. Health status of seniors and having a usual place for medical care affect the senior Tetanus and Shingles vaccination rates. While activity limitation may decrease the vaccination rate, having another chronic condition may increase the vaccination rate.

b. Demographics can affect the Tetanus and Shingles vaccination rates. Being a minority and male can affect the vaccination rate negatively. In contrary, being married or living with a partner can affect the vaccination rate positively.

c. Financial factors including household income, home ownership and insurance coverage affect the senior vaccination rate. Better financial status affects the senior vaccination rate positively.

d. Education status and internet literacy affect the senior vaccination rate. Higher education status, better internet literacy and having a usual place for medical care affect the vaccination rate positively.

Before explaining the methodology of this study in detail in Chapter 5, I will give background historical information about the Tetanus and Shingles preventative care in Chapter 2. Chapter 3 will discuss the Tetanus and Shingles preventative care policies of developed countries. Literature review and available theories are going to be discussed in Chapter 4. Furthermore, in Chapter 6 and 7, I will explain the results and discuss them.

CHAPTER 2

BACKGROUND: THE HISTORY OF TETANUS AND SHINGLES

PREVENTATIVE CARE

2.1 History of Tetanus

In 1884 Antonio Carle and Giorgio Rattone found the cause of Tetanus by injecting pus

of a dead human Tetanus patient into a rabbit. The following years Arthur Nicolaier discovered

that the main cause of Tetanus was a bacterium called Clostridium Tetani and suggested that the

bacterium lived in the soil by injecting the animals with soil. The same year Shibasaburo

Kitasato had a chance to analyze the bacterium and found out that the toxin produced by the

bacterium can be naturalized by some antibodies. An antitoxin was created for passive

immunization to be used to protect the soldiers from Tetanus in the World War I. In 1924 P.

Descombey developed the Tetanus toxoid after Gaston Ramon inactivated the toxin of the

bacteria by using formaldehyde several years beforehand. The developed Tetanus toxoid was

used in World War II for treatment and preventative purposes (CDC).

According to CDC, the first DTP vaccine was available in 1940s, when the Pertussis

vaccination was put together with Diphtheria and Tetanus toxoid to create a new vaccination

against all three diseases. The vaccine was produced by making Diphtheria, Tetanus and

Pertussis (DTP) nontoxic, but this nontoxicity did not make them uncapable of bringing out the

immune response in the person receiving the vaccination. As the vaccine does not contain the

live bacteria needed to duplicate themselves, it is crucial to receive several doses to create

immunity. The DTP vaccine consisted of four separate doses and was effective between 70 and

90% of the time, especially against pertussis. However, there were many complaints that the

vaccine had side effects in children like redness, pain and swelling at the place of injection. As a result of these side effects caused by the pertussis vaccine, in 1991, a more purified (acellular) form of pertussis vaccine was developed. DTP was replaced with DTaP, DT, Tdap and Td (CDC).

DTaP vaccination consists of Diphtheria and Tetanus toxoids with acellular pertussis vaccination which was specifically developed after the side effects of regular pertussis vaccination were reported. DTaP is given to children between the ages of six weeks and six years. One booster dose of Tdap, which contains Tetanus toxoid, decreased diphtheria toxoid and purified pertussis, is recommended when the child is 11 years old. After Tdap is given Td (without acellular pertussis) is recommended once in every 10 years as a booster. The booster vaccines are given as a precaution for the waning immunity. The seriousness of the waning immunity was seen in examinations conducted by Hibbert et al. between 1988 and 1994 for a cross-sectional survey of people living in the United States (2018). While protective antibodies for Tetanus and diphtheria were found in 91% of children aged between 6 and 11, this number was 47% in the adults aged 20 and over. The study results suggested out that protective antibodies were more likely to be present in people with higher education levels and higher incomes. The percentage of people with both protective antibodies decreased as the age of an individual increased. The study reports that only 31% of the people 70 and older were protected against the Tetanus and Diphtheria. The reasons for this low percentage, the study suggested, are waning immunity and never receiving the full dose of the DPT vaccine (Hibberd et al., 2018).

Figure 3 shows the incidence and death rates of Tetanus between the years of 1900 and 2015. While in 1900 there were approximately 2.4 deaths in 100,000 people, this number has

decreased to 0.4 deaths in 100,000 people and was very close to 0 in 2015. This decline is related to the use of Tetanus antitoxin for wound care since the 1900 and the use of Tetanus vaccine which became widely available since 1940s. There are about 30 Tetanus cases reported every year since 2010 and 11 to 15% of the cases result in death of the patient. In almost all of these reported cases the patient has incomplete vaccination or no vaccination at all.

2.2 History of Shingles

Although there is evidence, such as Egyptian medical documents dated from 1500 BC, that Shingles was present in ancient times, it was first discovered that Shingles arose from the dorsal root ganglion by the English doctor Richard Bright in 1831. This discovery was confirmed by German doctor Friedrich Wilhelm Felix von Barensprung in 1861. However, only at the end of the 19th century was evidence found that showed herpes zoster to be distinct from erysipelas, a bacterial infection that looks like Shingles. In 1906, studies showed that the herpes zoster is more complicated in elders. In 1949 Thomas H. Weller separated VZV by growing it in vitro inside of human tissue. By this isolation, he proved that there is a relationship between varicella and herpes zoster, and by 1952 Weller together with Stoddard proved that without VZV, varicella and herpes zoster viruses are identical. For his previous studies and this Shingles study, Weller received a Nobel Prize in Medicine in 1954. By the 1960s, several studies proved that the risk of the Shingles disease increased with age as cellular immunity decreased (Evans, 2010). The studies predicted that 500 out of 1000 people from the same cohort who would live until the age of 85 would get the disease at least once in their lifetimes and 10 out of 1000 people would have Shingles at least twice. In another population-based study done in Olmsted County, Minnesota

researchers discovered the occurrence rate of Shingles in the general population was 3.6 per

1000 patient years. This number increased to 10 per 1000 patient years in the 60 and older

population. About 70% of all the cases was seen in people aged 50 and older (Evans, 2010).
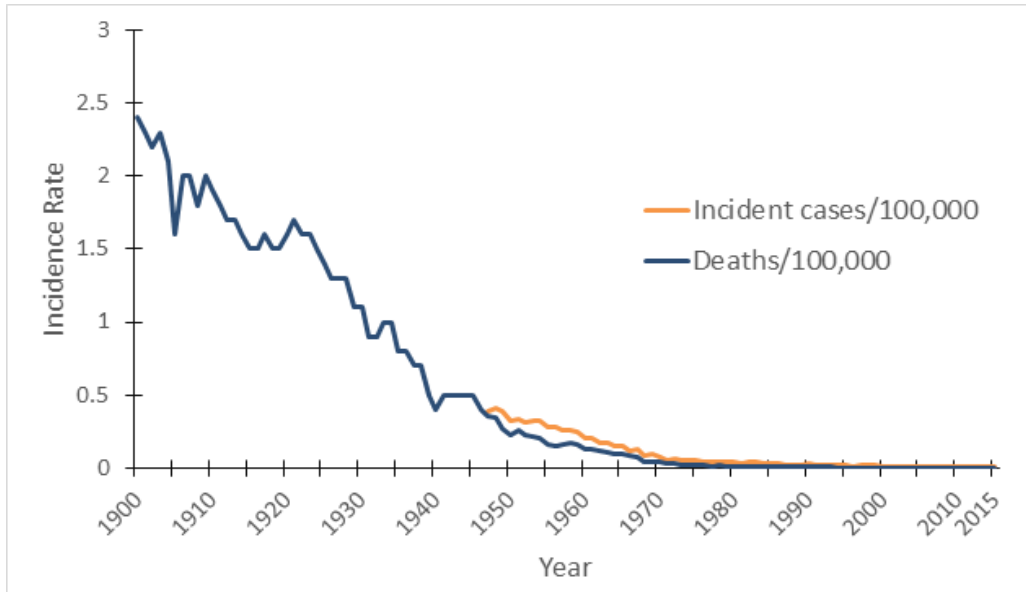
Figure 3: Declining Mortality and Incidence Rates of Tetanus between 1900 and 2015
Source: Manual for the Surveillance of Vaccine-Preventable Diseases. Center for Disease
Control and Prevention (CDC, 2017)

Before the early 2000s, the preventative care for herpes zoster was not available.

Antiviral drugs like acyclovir and valacyclovir have been used to reduce the symptoms of

Shingles. These drugs can decrease the risk of getting PHN and other complications by almost

half if taken as soon as the first symptoms of the disease start to occur. Table 2 lists the names of

possible Shingles complications and their definitions.

Prednisone can be used to decrease the inflammation and ease the pain of Shingles infection. Physicians, after treating the disease with antivirals, would send the patient home recommending keeping himself/herself busy by doing something so that the patient would not think about the pain and stress about it, as the stress could make the symptoms worse and lead to depression. It is even harder to prevent the patient from experiencing depression if he/she faces one of the complications of the disease, especially PHN which can cause excruciating pain for months or even years. Antivirals do not cure the herpes zoster but can ease the process and decrease the risk of getting complications (Evans 2010).

Although there are about one million reported Shingles cases and about 100,000 to 200,000 PHN cases reported annually in the U.S., until 2006 there was no preventative care available for the disease. Zostavax, which is a live attenuated viral vaccine, was developed by Merck & Co and was approved by Food and Drug Administration (FDA) in 2006. As of 2014 the vaccine was licensed in over 60 countries. The vaccine was made from the varicella (chickenpox) vaccine strain but on average has at least 14 times more "plaque forming units of vaccine virus" in one dose. This higher unit of vaccine virus is needed to raise an immune response in adults over 50. Herpes zoster vaccine has been reported as safe in many studies reporting only some swelling, pain and redness around the injection site which continued for fewer than four days.

The efficacy of the vaccine has been studied in November 1998 before the Zostavax was licensed. The study was randomized, double-blinded and placebo controlled which evaluated more than 38,000 adults aged 60 years and older. This crucial study was named the Shingles Prevention Study (SPS) and was conducted in 22 trial sites in the United States. All participants were followed for at least over three years to check if they had any incidence of Shingles. Only

95% of the recipients completed the study and among these people the group of 80 and older was

less than 7% which caused less analysis of the results for this age group. The study analyzed

Zostavax's efficacy in decreasing Shingles cases, PHN and the burden of illness (BOI).

Table 2: Possible Complications of the Shingles that can be prevented with Antiviral Drugs
Source: Importance of Vaccination Against Herpes Zoster by Diane Laura Evans, The Whole
Patient, February 2010.

Complications	Definitions
Postherpetic Neuralgia	a Shingles rash that lasts for more than a month
Bacterial Superinfection	an infection of the rash with different strains of bacteria
Cerebral Vasculitis	an inflammation of the blood vessels in brain and sometimes spinal cord
Esophagitis	an inflammation that may damage esophagus
Meningoencephalitis	an infection or inflammation of the brain
Motor Paralysis	paralysis of the voluntary muscles
Myocarditis	an inflammation of the heart muscle called myocardium
Pneumonitis	an inflammation of the lung
Transverse Myelitis	an inflammation of both sides of the one specific part of spine

In average the vaccine was 51.3% effective in preventing the Shingles cases. While there

were 5.42 cases per 1000 person years in vaccine recipients, this number was 11.12 cases per

1000 person years in placebo recipients. The efficacy increased to 66.5% when looking at the

PHN cases with 27 cases among the vaccine recipients vs. 80 cases among the placebo

recipients. The vaccine was 61.1% effective against BOI, which was calculated considering total pain, severity and length of Shingles. It was not a surprise that the study also found out that the efficacy of the vaccine to prevent the disease decreased as the age of the recipient increased; the effectiveness was 64% in the group aged 60-69 and it decreased to 38% in the 70 years and older age group. However, the success of the vaccine in preventing PHN was almost similar in both age groups. As there were about 2000 participants aged 80 and over, the result of the study for this specific age group was not statistically significant (Gabutti et al., 2014).

As an addition to the SPS study there were two separate studies: Short-Term Persistence Substudies (STPS) and Long-Term Persistence Substudies (LTPS). These studies were conducted to see how the efficacy of the vaccine decreased with time. STPS, which evaluated participants four to seven years after vaccination, found out that there was a decrease from 51.3% to 39.6% in efficacy of the vaccine against preventing Shingles cases and in LTPS, which evaluated participants seven to 11 years after the vaccination, this number had decreased to 21.1%. The success of the Zostavax in preventing PHN decreased from 66.5% to 60.1% and in LTPS the number decreased further to 35.4%. The vaccine's efficiency in reducing the BOI has decreased from 61.1% to 50.1% in STPS and in LTPS this number was as low as 37.3% (Gabutti et al., 2014).

The vaccine is not recommended for people who had severe reaction to varicella vaccine, people with active tuberculosis (TB), pregnant women and immunocompromised people who have weakened immunity either due to the disease or immunosuppressant medication they are taking. However, in the latter group the risks and benefits of getting the vaccine should be discussed with a physician.

In the fall of 2017, the FDA approved another vaccine to use against Shingles which was made by GlaxoSmithKline and named Shingrix. As soon as Shingrix was approved it became preferred over Zostavax because it offered better protection. CDC recommends two doses of Shingrix, which is a recombinant zoster vaccine, to adults aged 50 and older separated between two to six months. The efficacy of Shingrix in preventing Shingles has been estimated to be more than 90% when both of the doses are administered at the recommended time intervals. The efficiency of the vaccine remains more than 85% at least four years after the vaccine administration. In adults aged between 50 and 69 the efficiency of Shingrix to prevent the Shingles disease was 97% and in age group of 70 and older this number was 91%. The success of the vaccine to prevent PHN was 91% in the 50-69 age group and 89% in 70 and older age group. The efficacy numbers are only valid if the patient receives both doses at the recommended time of interval. These numbers are a lot better than the efficiency numbers of Zostavax, thus CDC recommends Shingrix to adults aged 50 and older. Shingrix is superior to Zostavax, not only in efficiency but also in the number of groups who can take it (CDC). While Zostavax was not recommended for immunocompromised patients, Shingrix does not have contraindication except for pregnant women, people with active Shingles, people without varicella immunity, and people who are in antiviral drugs. Zostavax can still be used if the patient is healthy and older than 60 years of age or if there is a shortage in Shingrix supply as it has been since the vaccine's introduction. The supply has not met the increasing demand. A similar shortage happened in the first years of Zostavax production, as the producer could not meet the demand of both the varicella and herpes zoster vaccines.

The high levels of efficiency come with the cost of several side effects. As the Shingrix gives above 90% protection the immune system of the vaccine, the recipient may react in ways that can prevent conducting daily activities. The common side effects are some swelling and pain in the injection site, while some patients may feel nausea, fatigue, headache, fever. One in six adults who received the vaccine reported some side effects that interfered with their daily activities, however, the recipients also reported that the side effects did not last longer than two to three days.

The preventative care has made a significant progress in the United States together with the rest of the world. The efficacies of the vaccines are proven and with the correct timing of the doses the preventable disease can be seen rarely. If enough information and financial assistance are provided, governments can save billions of dollars in inpatient and outpatient care. Looking at Tetanus and Shingles preventative care policies of some developed countries may give us some idea how other countries are dealing with Tetanus and Shingles.

CHAPTER 3

TETANUS AND SHINGLES PREVENTATIVE CARE POLICIES OF

DEVELOPED COUNTRIES

In the United States, neither Tetanus nor Shingles vaccines are covered by Medicare part B, which does cover major vaccines such as Influenza, Pneumococcal and Hepatitis B. Tetanus and Shingles vaccines are covered by Medicare part D for prescription medication, an optional plan which requires an additional premium for coverage. Therefore, seniors who are willing to get these important vaccines may either face a long process of filing for reimbursement or out of pocket costs ranging from $25-$75 for Tetanus vaccine, $25-$195 for Zostavax and $140 for each dose of Shingrix, the new vaccine that was approved in 2017. The U.S. vaccination policy recommends one dose of Tdap for the adults who are not sure if they had all doses of childhood Tetanus vaccination and, after that, a Td booster every 10 years. For Shingles vaccination, Zostavax is recommended after the age of 60 and both doses of Shingrix are recommended after the age of 50 (CDC).

Canada's adult vaccination policies are almost identical to that of the US: a Td booster every 10 years, and Zostavax vaccine after the age of 60. Only the province of Ontario offers free Shingles vaccines to seniors aged 65 to 70 (Public Health Agency of Canada, 2019).

3.1 Tetanus Vaccination Policy in Developed Countries

Table 3 is a summary of the Tetanus vaccination policy for adults in the European Union (EU) countries. There are no adult Tetanus vaccination recommendations in Denmark, Hungary, Ireland, Malta, Netherlands, Romania and the U.K. In Poland, although all Tetanus vaccines are

mandatory, the last dose of the vaccines is taken at the age of 19, and there is no recommendation for the Tetanus booster. Sweden recommends a Tetanus booster every 20 years after the last dose, while Austria recommends dTaP-IPV, which is a 4-in-1 vaccine containing Diphtheria, Tetanus, Pertussis (whooping cough) and Polio, every 10 years between the ages of 18-60 and every five years from 65 years of age. In both of these countries, booster doses of Tetanus are not covered by the National Health Services (NHS). In Bulgaria, Croatia, Czech Republic, Latvia and Slovenia, Td booster doses are mandatory. It is interesting to see that all of the EU countries with mandatory vaccination policies are former Eastern Bloc countries, as in the former Soviet Union, the state mandated all vaccinations. In Czech Republic and Bulgaria, the first mandatory Tetanus booster is at 25-26 years of age and every 10-15 years after that. In Portugal, the first three boosters each are 20 years apart at the ages of 25, 45 and 65; after the age of 65 the booster dose is recommended every 10 years. In Spain, after all of the doses of childhood Tetanus vaccination, only one booster dose is recommended at the age of 65. Belgium, Cyprus, Estonia, Finland, Germany, Greece and Italy have a recommended booster dose of Tetanus vaccine (mostly Td) every 10 years after the childhood vaccine recommendations are completed. In Lithuania recommended booster doses start at the age of 15 and repeated every five to10 years; certain in risk groups are recommended the booster dose every five years. In France, the 5-in-1 vaccine dTacp-IPV, which is a combined vaccine of diphtheria, Tetanus, whooping cough, polio and Hib diseases, is recommended before 65 years of age and after that dTT-IPV after 65 every 10 years. Hib is caused by a bacterium Haemophilus influenzae type b and can result in serious disability or death. dTacp-IPV booster is recommended once every 10 years in Luxembourg.

In 2015 and 2016 combined, there were 206 Tetanus cases reported in the EU, however Austria, Belgium, Finland and Germany do not report data, and the 206 cases were from the rest of the EU. Of these cases, 69% (142) were seen in adults aged 65 and older. Almost 38% (78) of these cases were in Italy only; another 45% of the cases were in France (16), Poland (24), Spain (18), UK (12), Romania (13) and Greece (9). While looking at these numbers we need to keep in mind the total population of each country: 78 cases in Italy from 60 million population; 16 cases in France from 67 million population; 24 cases in Poland from 38 million population; 18 cases in Spain from 46 million population, 12 cases in UK from 65 million population; and 9 cases in Greece from 10 million population. It should be noted that there were no reported cases of Tetanus in 2015 and 2016 in Cyprus, Estonia, Latvia, Luxembourg, Malta and Slovakia. Among these countries Latvia is the only one with mandatory Tetanus booster policy and only Malta does not have an adult Tetanus vaccine recommendation. It is interesting to see that despite of the Italy's Tdap recommendation every 10 years, it has the greatest number of reported cases (European Centre for Disease Prevention and Control).

Table 3: Adult Tetanus vaccination policies in EU countries
Source: European Centre for Disease Prevention and Control, 2019

EU Country Name	Tetanus Vaccine Policy
Austria	dTaP-IPV every 10 years between 18-60 years of age and every 5 years from 65 years of age booster vaccines not covered by the NHS
Belgium	dTT every 10 years for adults
Bulgaria	mandatory Td booster every 10 years from 25 years of age
Croatia	Booster vaccines after 60 years of age are mandatory
Cyprus	Td booster every 10 years from 25 years of age

Czech Republic	First booster doze at 25-26 years of age, next dozes every 10-15 years - mandatory
Denmark	No recommendation for adults
Estonia	Td booster every 10 years from 25 years of age
Finland	Td booster every 10 years after the childhood doses are completed
France	dTacp-IPV or dTT-IPV if last dTacp-IPV received in the previous 5 years
	dTT-IPV every 10 years from 65 years of age
Germany	Booster doses every 10 years
Greece	Td booster every 10 years
Hungary	No recommendation for adults
Ireland	No recommendation for adults except for pregnant women
Italy	Tdap is recommended every 10 years from 19 years of age
Latvia	Mandatory Td boosters every 10 years and more frequent for risk-groups.
Lithuania	Booster doses start at 15 years of age every 5-10 years
Luxembourg	Tdacp-IPV booster every 10 years
Malta	No recommendation for adults
Netherlands	No recommendation for adults
Poland	The latest recommended dose is at 19 - mandatory
Portugal	Td booster at 25, 45, 65 and every 10 years after that
Romania	No recommendation for adults
Slovakia	From age 30 Td booster every 15 years
Slovenia	Mandatory Td booster every 10 years
Spain	One booster dose at 65 years of age
Sweden	dT booster every 20 years – not funded by NHS
United Kingdom (UK)	No recommendation for adults

In Japan, there is no Tetanus vaccine recommendation for adults. Additionally, the immunization program is not funded by the Japan NHS; the funding has been decided by the local governments. There are approximately 100 Tetanus cases per year and 94% of these cases

are with patients over 40 years of age and 18% are over 80 years of age. In 2008 in the general

population there were 0.98 cases per million people and in the population of people over 80

years of age this number is as high as 3.6 cases per million people (Nikayama, 2013; Shimazawa

& Ikeda, 2012). The Australian Immunisation Handbook reports that the first booster dose of

Tetanus is recommended at the age of 11-13 and booster doses for adults start at the age of 50 if

the previous booster was given more than 10 years ago. It is recommended to get a booster dose

once in every 10 years. There are approximately 10 reported cases per year and 62% of the cases

are seen in people aged 65 and older (Australian Institute of Health and Welfare, 2018). On the

other hand, New Zealand recommends the first booster dose at the age of four and 11. For the

adults there are two booster recommended ages: 45 and 65. Because of successful immunization

policy there are fewer than five reported Tetanus cases seen in New Zealand (Health Navigator

New Zealand, 2020).

3.2 Shingles Vaccination Policy in Developed Countries

Although herpes zoster is not a new disease, the first vaccine (Zostavax) against it was approved

and registered only in 2006. After a decade, in 2017, the second vaccine (Shingrix) has been

registered and is proven to be more effective than the first vaccine.

After analyzing recommended Tetanus vaccination policies in EU countries, it is

interesting to see very few countries with recommended Herpes Zoster vaccination policies.

Among 28 EU countries only six of them have a policy (Table 4). In Austria the vaccine

recommended age is 50 and over, however the vaccine is not funded by the NHS. The Czech

Republic is one of the countries with more than one Herpes Zoster vaccine recommendation:

while the recommended age group is 50 and over, it is 18-49 for the at-risk groups. France has

the recommended age at 65 and in Greece the age is 60. Italy recommends the vaccine to the

people aged 65 and older, however for the specific groups the age is lowered to 50-64. The UK's

age recommendation is higher than that of the other EU countries:70 and older. These age

recommendations may change after the wide availability of Shingrix which is recommended for

everybody aged 50 and older. Despite of the possible decrease in the recommended age, the

vaccine of the adults younger than specific age may not be funded by the NHS.

Australia and New Zealand recommend the vaccine to people aged 50 and older if there

is an immunocompromised person in the household; however, New Zealand does not fund it.

Australia recommends the vaccine for people aged 60 and older but only funds the vaccines for

the 70-79 age group. New Zealand's general recommendation age is 65 and older and the

vaccine is free for the 65-80 age group. In Canada the vaccine (Shingrix) is recommended for

people aged 50 and older but the vaccine is only free in Ontario and for only 65-70 age group.

Japan recommends the vaccine for everybody aged 50 and older but the funding does not come

from the NHS; only local governments can decide whether the vaccine should be funded or not.

Although there are very few European countries with recommended HZ vaccine policies,

it is estimated that the HZ incidence rate is between 2.0 and 4.57 per 1000 person-years

depending on the country. The lowest incidence rate, 2.0/1000 person years was seen in Iceland,

Germany and Switzerland. The UK, Netherlands and France had a medium incidence rate,

3.0/1000 person years, among the European countries. The incidence rate was higher, 4.0/1000

person years in Belgium, Spain and Italy. In a 2013 study Pinchinat et al. estimated the average

HZ incidence rate in the EU to be 3.4/1000 in all age groups combined. If we take the EU's

population into consideration this incidence rate means that 1.7 million new Shingles cases can

be seen every year in the EU altogether. In the United States, the Shingles incidence rate is

estimated to be four cases per 1000 people and according to this rate, it is estimated that there are

about one million new cases every year.

Table 4: EU and Some Developed Countries with Shingles Vaccination Policy in Effect
Source: European Centre for Disease Prevention and Control, 2019
Health Departments of Canada, Australia, New Zealand and Japan, 2019

Country Name	Shingles Vaccine Policy
Austria	Recommended for people aged 50 and older – not funded by NHS
Czech Republic	Recommended for specific groups aged 18-49 Recommended for people aged 50 and older
France	Recommended for people aged 65 and older
Greece	Recommended for people aged 60 and older
Italy	Recommended for specific groups aged 50-64 Recommended for people aged 65 and older
UK	Recommended for people aged 70 and older
Canada	Recommended for people aged 50 and older Free in Ontario for people aged 65-70
Australia	Recommended for people aged 60 and older Free for people aged 70-79 Recommended for people aged 50 and older if there is an immunocompromised person in the household
New Zealand	Recommended for people aged 65 and older Free for people aged 65-80 Recommended for people aged 50 and older if there is an immunocompromised person in the household – not funded
Japan	Shingrix is recommended for people aged 50 and older

Although Norway does not have a Shingles vaccination policy (2019), Mirinaviciute et

al., published an article (2019) studying the burden of Norwegian Shingles cases that needed

medical attention. They have found that among the general population of Norway 82,064 non-

vaccinated people needed medical care between 2008-2014. Annually there were 227.1 cases per

100,000 in primary health care while this number was 24.8 cases per 100,000 in hospitals. In the "adults over 50" population these numbers were more than doubled. There were 461 cases per 100,000 in primary cares and 57 cases per 100,000 in hospitals. In both analysis, there were more women seeking medical help than men. Almost half (47%) of hospital patients had a complication resulting from Shingles, and 25% of hospital patients had two or more chronic conditions, which was increasing the number of hospital stays. The median hospital stay was four days (Mirinaviciute et al., 2020).

It is interesting to see that some of the developed countries with advanced preventative care policies do not have any policy regarding Shingles vaccination. Two of those few countries, Austria and New Zealand, do not fund the vaccine. Comparing to other adult/senior vaccinations, Shingles vaccinations are new. Although Zostavax has been around for 12 years, Shingrix only has been available since 2018. As the latter drug's efficacy has been higher than that of Zostavax, it may cause the rest of developed countries to consider adding the preventative care recommendation for Shingles disease. Especially countries with aging population should consider funding the vaccination to decrease the number of people suffering from long time complications of the diseases.

CHAPTER 4

LITERATURE REVIEW

4.1 Models

Health Belief Model (HBM)

This model suggests that six concepts predict health behavior: risk susceptibility, benefits to action, risk severity, self-efficacy, barriers to action, and cues to action.

The Transtheoretical Model (Stages of Change)

This model was developed in the late 1970s and analyzes the decision-making of the individual. It proposes that behaviors do not change quickly, but rather progress through six cyclical stages: precontemplation, contemplation, preparation, action, maintenance, termination.

4.2 Supply Side Factors

In December 2011 the United States Government Accountability Office (GAO) prepared a Report to Congressional Committees which included surveys done with physicians and pharmacies about Td/Tdap vaccine. While most of the studies analyze the demand side of the senior vaccination problem, GAO surveys the supply side to give another perspective to the problems of the low senior vaccination rate. Figure 4 shows that 46% of the physicians surveyed said that they always recommend the Td/Tdap vaccine while the number is 33% for Zostavax. The survey also showed that 28% of the physicians responding usually recommend the Td/Tdap vaccine and 26% recommend the vaccine about half the time or less, while 36% usually recommend Zostavax and 32% recommend the vaccine about half the time or less. In 2017 the

Tetanus vaccination rate and Shingles vaccination rate among seniors were 56.9% and 34.2% respectively. Recommendation from physicians, especially primary care physicians, may increase the number of seniors getting a vaccination as patients mostly trust their PCPs. Why do not 100% of the physicians always recommend the vaccine? Why is this number only 46%? Understanding the problems and complications of supply side of the Td/Tdap and Shingles vaccine can be another research topic.

The results of the beneficiary declining to take the Shingles and Td/Tdap vaccines after their physician's recommendation are shown in Figure 5. While more than half (64%) of the patients who are recommended Td/Tdap vaccine never or occasionally decline it, 32% of the patients decline the vaccine about half the time or more. Even though Td/Tdap vaccine has been around for decades and its efficacy has been proven, more than one-third of patients decline the vaccine half the time or more.

Figure 4: Physician Recommendations for the Shingles and Td/Tdap
Source: The United States Government Accountability Office 2010 Physician Survey

Figure 5: Beneficiary Declinations of Shingles and Td/Tdap After Physicians Have Recommended Them
Source: The United States Government Accountability Office 2010 Physician Survey

The numbers are even more bothersome for the Shingles vaccination, with 46% of patients declining the vaccine about half the time or more, and another 46% never or occasionally declining the vaccine. Why do 46% of the patients decline the vaccine half the time or more? The Shingles rash is painful, and can lead to severe pain for a prolonged period of time: weeks, months or even years.

Figure 6 shows that only 21% of the surveyed pharmacies stock the Td/Tdap vaccine. While 61% refer patients to physicians for vaccination, 16% of pharmacies do not stock the vaccine and do not refer the patients to physicians, while 35% of pharmacies stock Zostavax (which at the time of the survey was the only vaccination against Shingles) and 65% of them do not have the vaccination in stock. A pharmacy is a place where you can get your vaccinations without appointments and long waiting times. More pharmacies stocking Td/Tdap and Shingles

vaccines may help increase the number of seniors getting their recommended vaccinations.

Understanding the reason why most (79%) of the pharmacies do not have the vaccines in stock

may help increase the senior vaccination rate. Discovering the shortcomings of the supply side

and analyzing those shortcomings with the demand side complications may help find more

effective solutions.

Figure 7, on the other hand, shows the percentage of the physicians who stock and do not

stock Shingles and Tetanus vaccinations. Most physicians (83%) stock the Tetanus vaccine, but

only 31% carry the Shingles vaccine. Zostavax has a short shelf life, which discourages

physicians to have it in the office ready for their patients. Shingles vaccinations, contrary to flu

shots, are not available in all pharmacies or physicians' offices. The drug's short shelf life means

that, if not used in the short time frame, the vaccination cannot be used and the money spent for

the vaccination is wasted. This may be one of the reasons why only 33% of the

physicians always recommend Shingles vaccination (The United States Government

Accountability Office, 2011).

4.3 Financial Factors

According to the US Department of Health and Human Services, all of the vaccinations

recommended by an Advisory Committee on Immunization Practices (ACIP) before 2009 are to

be given to the people enrolled in new group or individual health plans under the Affordable

Care Act (ACA) without co-payments or any kind of cost-sharing, but only if the vaccines are

given by in-network health providers. If a person does not meet ACIP age recommendations for

that specific vaccine, he/she may face high co-payments.
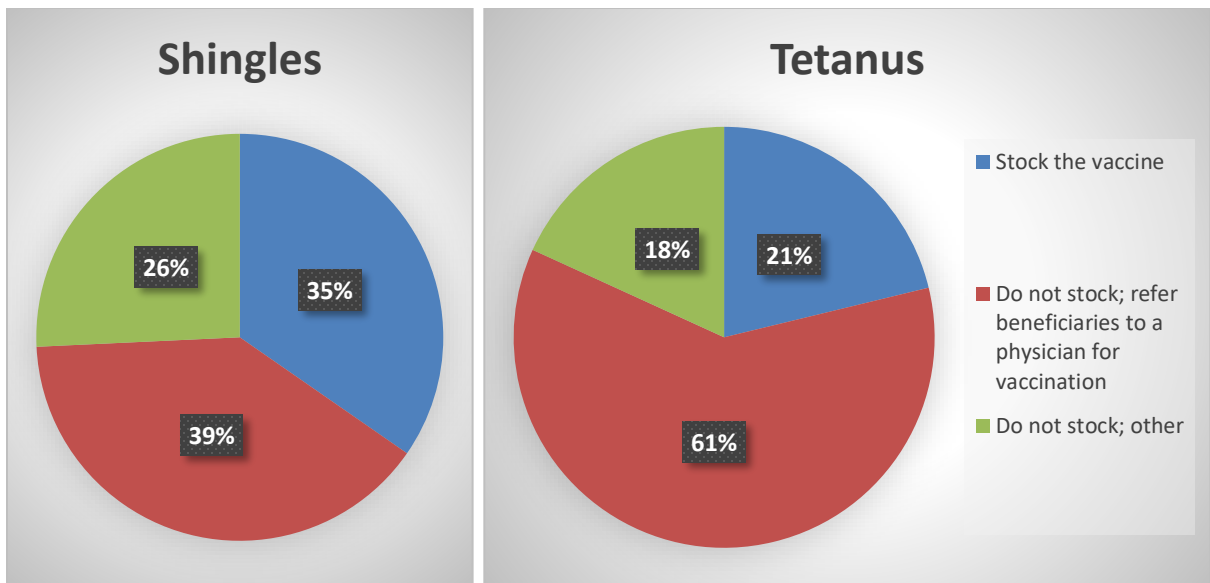
Figure 6: Pharmacies Stocking the Shingles and Td/Tdap Vaccine
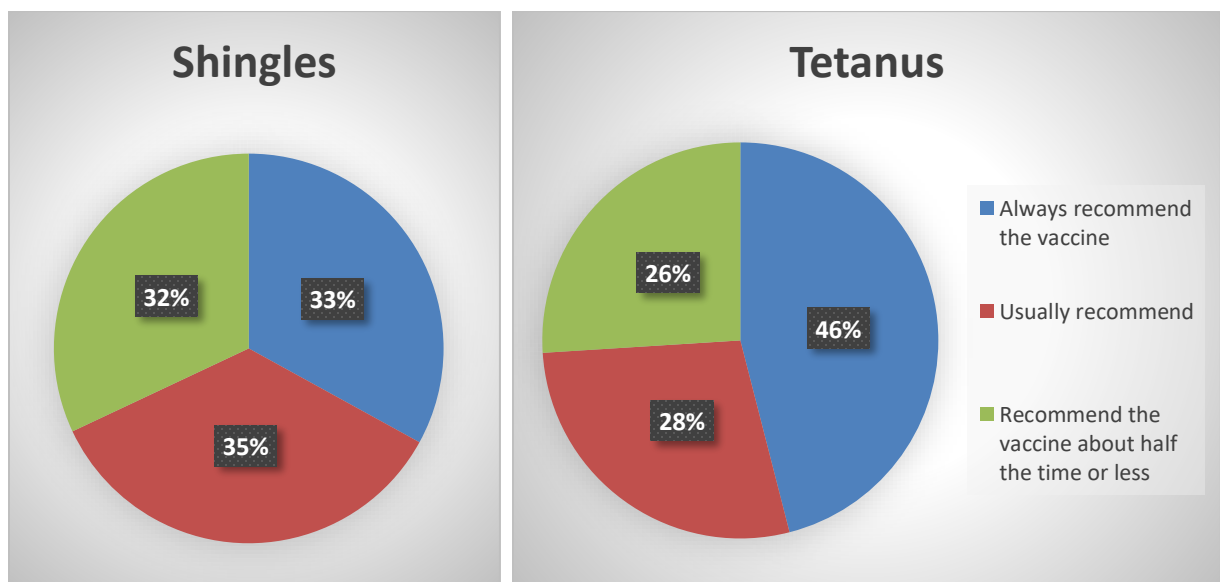Source: The United States Government Accountability Office 2010 Pharmacy Survey
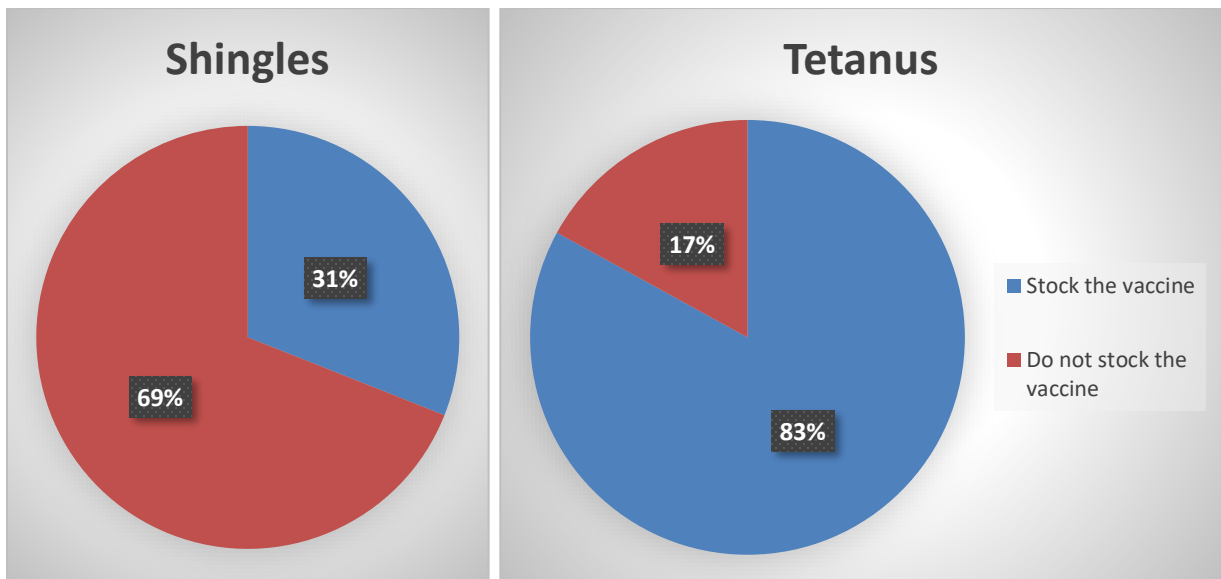
Figure 7: Physicians Stocking the Shingles and Td/Tdap Vaccine
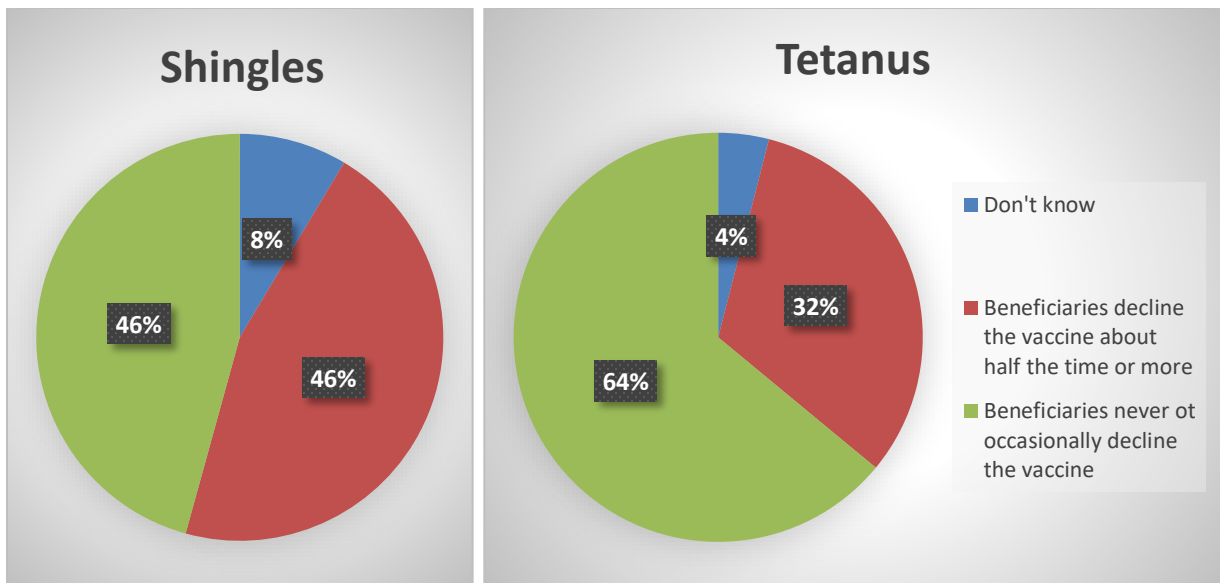Source: The United States Government Accountability Office 2010 Physician Survey

Table 5 (CDC) summarizes four main senior vaccine recommendations and their Medicare coverage. While Hepatitis B is covered by Medicare Part B only for certain risk groups, Influenza and Pneumococcal vaccines are covered for all. If one is not included in certain risk groups, then Hepatitis B is covered under Medicare Part D. The Tdap/Td vaccine is covered under part B after the patient had been exposed to the Tetanus, otherwise it is only covered by Part D. Shingles vaccine (Zostavax) is only covered under Part D. The vaccines that are covered under Medicare Part D have some kind of cost-sharing depending on the plan the patient is enrolled in. Hurley et al., mention that some plans under Medicare Part D require patients to pay for the vaccines out-of-pocket and then file for the reimbursement which adds a burden to the patient (Hurley et al., 2008). According to CDC Vaccine Price List of 2019 one dose of Tetanus and Diphtheria Toxoids (TDVAX) costs $25.12; one dose of Tetanus Toxoid, Reduced Diphtheria Toxoid and Acellular Pertussis (Boostrix) costs $41.19, while a dose of Adacel costs $45.50. CDC's cost for one dose of Shingrix is $102.90, while in the private sector it costs $144.2. These costs may add an extra burden for seniors who have limited financial resources.

When discussing the financial factors affecting the vaccination rate in seniors, we need to make sure we are not only discussing the monetary aspect (ability to pay or willingness to pay) of the vaccinations. Seniors who lack access to transportation or who lack a usual source of health care will have difficulty getting their recommended vaccinations and recommended check-ups. Many seniors may not drive and/or may live in areas without accessible public transportation. Seniors who do not have Medicare part D coverage or private insurance to cover the out-of-pocket costs will have more financial burden from a vaccine which requires a copay.

If we increase the affordability of the vaccine and make access to the vaccine easier, economic

theory suggests that we will reach greater vaccine utilization (Alliance for Aging Research).

Table 5: ACIP Vaccine Recommendations and Medicare Coverage
Source: ACIP Vaccine Recommendations, Centers for Disease Control and Prevention

Vaccine	ACIP Recommendation	Part B Coverage	Part D Coverage
Hepatitis B	All infants at birth and adults in certain risk groups	✓ (in certain risk groups)	✓
Influenza	Annually for all people over the age of 6 months	✓	
Pneumococcal	Persons age 65 and over, immunocompromised adults aged 19-64, children in certain risk groups, and children younger than five	✓	
Tdap/Td (Tetanus)	All children are vaccinated with DTaP (or DT, if contraindications are present). Adolescents receive a course of Td and Tdap. Adults receive a regular booster of Td or Tdap every ten years and/or after exposure	✓ (after exposure)	✓
Zoster (Shingles)	Once for adults over the age of 60		✓

In the study done by the Alliance for Aging Research 12 different variables were

analyzed to test the effect of financial factors on Tetanus and Shingles vaccination rates. Five of

the variables were found to be insignificant, one had a small effect, three had a moderate effect,

and three others were found to have a large effect on Tetanus vaccination rate. Delaying care

because of lack of transportation, having a usual place for medical care and having an additional

insurance coverage (military coverage) had large effects on the senior Tetanus vaccination rate.

In 2016, Kwon et al., studied the factors affecting the influenza vaccination rate among seniors in South Korea and found out that one of the two main factors affecting influenza coverage was a recent history of a doctor visit; this aligns with the findings of the previous research (Alliance for Aging Research). One of the other important factors was seniors' household income (Kwon et al., 2016).

Looking at the CDC 2009 National Health Interview Survey, the United States Government Accountability Office reported that seniors with Medicare Part D and private or other coverage are more likely to get vaccinated against Tetanus and Shingles, which are two main senior vaccinations not covered by Medicare Part B, than seniors without Medicare Part D and private or other coverage. The information they have provided is consistent with the fact that seniors who are enrolled in Medicare Part D or have another health coverage are more likely to get the vaccines and medications that are covered by Part D. Also important to note are the Tetanus vaccination rates in 2009 and 2015. While 52.8% of senior adults were vaccinated against Tetanus in 2009, this number had only increased to 56.7% in 2015, which is less than 4% increase in six years.

In 2011 Streeter et al. analyzed the factors affecting the abandonment of oral oncolytic prescriptions and found that patients who have high-cost sharing and lower income are more likely to abandon their prescriptions. Another factor affecting the abandonment rate was Medicare coverage, which is consistent with the cost sharing factor affecting the rate. In 2016, Akinbosoye et al., conducted a similar study but this time the study subject was not the abandonment of oral oncolytic prescriptions but the abandonment of Zostavax prescription. Results showed that about 173,000 Zostavax prescriptions were filled and more than 67,000 of

those prescriptions were abandoned, which equals a 38.9% abandonment rate. Factors such as patient demographics and insurance coverage were significant, but the most significant factor was out of pocket costs. Higher out-of-pocket costs were associated with higher abandonment rates. This factor remained the most significant predictor of prescription abandonment even after the authors adjusted for the other two significant factors: insurance coverage and demographics.

In 2020 Martins et al., published an Ontario, Canada based time series study. In the beginning of 2016, Ontario residents aged between 65-70 could get Zostavax vaccine free of charge through an immunization program that was publicly funded. Martins et al., wanted to see if the free public immunization program had any effect on the Shingles burden in this population. They discovered that the immunization program decreased the outpatient visits resulting from Shingles by 19.1% while emergency room visits and hospitalizations decreased by 38.2%.

4.4 Information Factors

Living in the age of information where one can search for anything that comes to one's mind and find hundreds and thousands of sources of information, information factors should not significantly affect seniors' Tetanus vaccination rate. When discussing information factors, we should not forget that many elderly are computer/internet illiterate. Another thing we should keep in mind is the antivaccine movement, which uses debunked research to scare people about possible side effects of the vaccines.

Johnson et al., in their 2008 study discovered that while most of the people surveyed knew about the Tetanus vaccine, only 36% of adults were aware of the Tetanus booster vaccine, which should be received every 10 years, and 34% of adults responded that they have doubts

about vaccinations, such as the influenza vaccine. While surveying the reason they were not up to date with their vaccinations, more than half of the adults answered that their physicians did not say that vaccinations were needed. Another important reason was the belief that healthy adults do not need a vaccination; 74% of respondents believed that they only needed a Tetanus vaccination after an injury.

The Alliance for Aging Research used two different variables to test the role of information factors, and both variables had large effects on the Tetanus vaccination rate. The first variable was education status and the second variable was "looked up health information on internet." Both of these variables focused only on internet literacy. A qualitative study done in Manchester, United Kingdom held in depth interviews with ten seniors aged 75 and older about the influenza vaccination. There were three main concerns about the vaccination: the question of trusting and not trusting the modern medicine, previous experience with the vaccine and a perceived risk from the influenza (Telford, 2003). As the immunity of children and seniors are weaker than for healthy adults, many preventable diseases affect them more than other groups. Changing seniors' perspective about the vaccinations may decrease hospital stays and deaths from complications.

Cochrane Collaboration conducted a study in 2018 and asked if "increasing demand, vaccination access and provider activity increase influenza vaccination rates in people aged 60 and older living in the community." They analyzed 61 trials with over one million participants who lived in high-income countries. There were three key results: increasing community demand for vaccination with reminders in the form of leaflets, phone calls, nurse or pharmacist

education; increasing access to vaccinations with free home visits, client group clinic visits and offers of free vaccinations (Thomas & Lorenzetti, 2018).

Seniors' views and opinions about the vaccination, its benefits and possible side effects should be discussed with knowledgeable and reliable sources like their primary care physicians as seniors decide about taking a vaccination or not by evaluating what they know (Eilers et al., 2014). As the result of trust given to physicians, health care providers should spend more time in explaining vaccinations and their personal experience of treating patients with different kind of diseases that could have been prevented with the help of vaccinations. Doctors are the ones that could eliminate the misconception about the effectiveness of vaccinations and their side effects as they and their opinions are valued by their patients (Tabbarah et al., 2005; Teeter et al., 2014). Additionally, sending extra information by mail and electronic message can strengthen the information fundamentals given during the face-to-face office visits (Otsuka et al., 2013). Local and state health departments together with local aging network should organize events that can inform about the risks of diseases; however primary care physicians play crucial role in acknowledging seniors (Zimmerman et al., 2003).

4.5 Other Factors

The Alliance for Aging Research found that having a health condition that needed to be controlled by a physician increases the chance of getting the recommended vaccinations. If a senior has a chronic health condition that requires a doctor's care, the senior will have to visit physicians more often than the one who does not have a poor health condition or chronic diseases. More doctor visits get the senior more face-to-face time with the physicians who can

recommend, follow up or give more information about the available and recommended

vaccinations. In South Korean seniors, Kwon et al., had similar results: the health status of the

senior and daily activity limitation affected the rate of the influenza vaccination.

CHAPTER 5

METHODOLOGY

5.1 Source of Data

"The IPUMS National Health Interview Series (IPUMS NHIS) is a harmonized set of data and documentation based on material originally included in the public use files of the U.S. National Health Interview Survey (NHIS) and distributed for free over the internet" (IPUMS NHIS "Frequently Asked Questions"). The IPUM NHIS is user friendly with its data extraction system, which allows researchers to choose the years and variables they want to analyze. Although keeping the question wording the same, NHIS changes variable names which can make the job of the researchers more complicated as one would have difficulty to figure out if the same variables are available across different years. The IMUPS NHIS keeps the variable names consistent and gives a user-friendly display of years, topics and variables.

The Shingles vaccination has been around for less than 15 years. In the first years a large component of the target population was not aware of the Zostavax. Comparing Shingles to another vaccination which has been around for decades could help us to understand our results and strengthen our hypotheses. Tetanus is a good choice for the comparison of the analysis as it has been widely available for approximately 80 years, and, like Zostavax, it is not covered by Medicare Part B and requires an out of pocket cost.

5.2 Dependent Variable

For Tetanus analysis: had Tetanus shot in the past 10 years (Yes/No – Nominal variable) (SHOTET10Y) where "No" is coded as 0 and "Yes" is coded as 1.

For Shingles analysis: ever had Zoster Vaccine (SHOTZOSTEV): In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

5.3 Independent Variables

1-Sex (SEX): I examine whether the vaccination rate is affected by gender. I hypothesize that women have a higher Tetanus/Shingles vaccination rate. In our logistics regression "Male" is coded as 0 and "Female" as 1.

2- Marital status including living with partner (MARTSCOHAB): Being married or living with a partner can increase the vaccination rate, as there is someone else caring about him/her. It can also indicate that he/she would take good care of himself/herself because of a spouse/partner. I hypothesize that married people and people living with partners have higher Tetanus/Shingles vaccination rate than the ones living alone. In our logistics regression "Married, spouse present" is coded as 0 and others ("living with partner", "married, spouse absent", "separated", "divorced", "widowed", "never married") are coded in an increasing order.

3-Main racial background (RACEA): the literature review stated that racial background affects vaccination rates, with people of color having lower vaccination rates than Whites. In our logistics regression "White" is coded as 0 and others ("Black/African American", "Alaskan Native or American Indian", "Asian/Indian Asian") are coded in an increasing order.

4-Educational attainment (EDUC): This variable could indicate a senior's ability to understand

information given and to search for answers and explanations. I hypothesize that higher education level is associated with a higher vaccination rate. In our logistics regression "Never attended" is coded as 0 and others ("some schooling but no high school diploma", "high school diploma", "Some college and AA degree"; "Bachelor's Degree"; "Master's, Professional, or Doctoral Degree") are coded in an increasing order.

5-Above or below poverty threshold (POORYN): Being below poverty would decrease vaccination rate as Tetanus/Shingles vaccines are not covered by Medicare Part B and require out of pocket expenses. Additionally, for people living below poverty level, transportation could be an issue. In our logistics regression "At or Above Poverty Threshold" is coded as 0 and "Below Poverty Threshold" is coded as 1.

6-Family's home owned or rented (OWNERSHIP): Another variable to analyze income of the seniors. In our logistics regression "Owned or Being Bought" is coded as 0 and "Rented"/ "Other Arrangement" are coded as 1.

7-Health status (HEALTH): seniors with chronic illnesses may be more likely to see their physicians regularly and thus have a higher rate of vaccination than healthy seniors who do not visit their doctors on a regular basis. In our logistics regression "Excellent" is coded as 0 and others ("Very Good"; "Good"; "Fair"; "Poor") are coded in an increasing order.

8-Scheduled appointment with health care provider on Internet, past 12 months (PCAPPTHPYR): This variable and the two following variables indicate if the respondent has computer/internet literacy, a potentially important component in getting information. Researching on the Internet may allow respondents to look at vaccination from different perspectives. Computer literacy is hypothesized to affect Tetanus/Shingles vaccination rates positively. Being able to schedule an appointment with a doctor through the Internet saves time waiting on the phone line. It is easier, thus more preferred. If one does not have computer/Internet literacy, he/she may not be motivated enough to wait on the phone line to schedule an appointment. In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

9-Communicated with health care provider using E-mail, past 12 months (PCEMAILHPYR). In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

10-Looked up health information on Internet, past 12 months (PCLOOKHELYR). In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

11-Has usual place for medical care (USUALPL): If a senior has a primary care doctor, she/he has somebody that can be trusted for reliable information. According to the literature review, seniors trust the doctors who they see on a regular basis. Having a usual place for medical care is hypothesized to have a positive effect on Tetanus/Shingles vaccination rates. In the logistics regression "There is no place or No" is coded as 0 and "Yes, has a usual place or Yes"/ "There is more than one place" are coded as 1.

12-Medical care delayed due to cost, past 12 months (DELAYCOST): If medical care has been

delayed due to financial reasons, it could affect the vaccination rate negatively as

Tetanus/Shingles vaccinations are not covered by Medicare Part B and requires seniors without

alternative insurance coverage pay out of pocket fees. In our logistics regression "No" is coded

as 0 and "Yes" is coded as 1.

13-Delayed care because lacked transportation (DELAYTRANS): Availability of transportation

is another factor that could affect the Tetanus/Shingles vaccination rates. In our logistics

regression "No" is coded as 0 and "Yes" is coded as 1.

14-Has any Medicaid/other public assistance (HIPUBCOVE): This variable and the following

two variables are used to determine if the senior would have to pay out of pocket fees to get

Tetanus/Shingles vaccinations. If one has more than one insurance policy, it is possible that the

Tetanus/Shingles vaccinations would be fully covered, which would affect the vaccination rate

positively. In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

15-Covered by private health insurance (HIPPRIVATEE).
In our logistics regression "No" is coded as 0 and "Yes, information"/ "Yes, but no information"
are coded as 1.

16-Covered by military health insurance (HIMILITE). In our logistics regression "No" is coded

as 0 and "Yes, information"/ "Yes, but no information" are coded as 1.

17-Region (REGION): living in a particular geographical regions may affect senior Tetanus/Shingles vaccination rates. In our regression "Northeast" is coded as 0 and others ("North Central/Midwest"; "South"; "West") are coded in an increasing order.

18- (This variable is for Tetanus vaccination analysis.) Ever had Zoster Vaccine (SHOTZOSTEV): Zostavax is a vaccine used to prevent Shingles. The vaccination rate of Shingles among seniors is about 34%. There may be several reasons for a low vaccination rate. Two of them are financial and informational. The Shingles vaccination has high out of pocket costs as it is not covered by Medicare Part B and it is a decade old vaccination. In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

19- (This variable is for Shingles vaccination analysis.) Had Tetanus shot in the past 10 years (Yes/No – Nominal variable) (SHOTET10Y) where "No" is coded as 0 and "Yes" is coded as 1.

20- Had Flu Shot Vaccine in the Past 12 Months (VACFLUSH12M): The flu shots are given once a year and is especially recommended for children under five, pregnant women, people with chronic conditions and seniors. The vaccination is covered by all types of insurances and in many cases is given free of charge. This variable will help us to understand if the senior is against vaccinations altogether. In our logistics regression "No" is coded as 0 and "Yes" is coded as 1.

21-Has any activity limitation (LANY): A significant activity limitation may be associated with problems in seeing a physician. In our regression "Limited in any way" is coded as 0 and "Not limited in any way" is coded as 1.

5.4 Control Variable – Sample Years – Sample Size

Control Variable:

Age: I am controlling the age of the respondents as we are interested in people aged 60 and over.

Sample Years:

2009, 2011, 2012, 2013, 2014, 2015, 2016, 2017

Sample Size:

There were total of 62,377 observations in both of the analysis.

5.5 Statistical Analysis

Logistic Regression

This regression method is used because there is one nominal dependent variable and 21 measured independent variables. The model assesses the relative effects of the various independent variables on the dependent variable.

CHAPTER 6

RESULTS

6.1 Descriptive Statistics

Table 6 is the summary of the total number of people (and percentages) who received and did

not receive Tetanus Shot in the last 10 years. Compared to Zostavax (27.3%), more people

received Tetanus Shot (41.9%) in the sample year.

Table 6: Number and Percentage of People Who Received/
did not Receive Tetanus Shot and Zostavax.

	Yes	No
Tetanus Shot Last 10 Years	26145	36232
	41.9%	58.1%
Zostavax	17024	45353
	27.3%	72.7%

In Table 7, I have included five variables that describe the demographics of respondents.

In Region variable, we can see that the lowest percentage is in South (25.84%) and the highest

two are North Central/Midwest (32.77%) and West (32.71%). The sex variable shows that a

higher percentage of females (31.64%) were vaccinated against Shingles than of males (27.38%).

The Black/African American category in the Race variable has the lowest percentage (13.73%)

while the White category has the highest percentage (32.38%). Education variable did not

surprise me: higher the education higher the percentage of people who received the Zostavax.

Poverty level does not only affect the vaccination rate of Zostavax, which requires copay, but it

also affects the rate of vaccinations that are fully covered under Medicare. Only 14.22% of

people below poverty threshold reported that they have received the Shingles vaccination. This

percentage is higher (31.9%) in people living at or above the poverty threshold.

Table 7: Zostavax and Demographic variables in numbers.

		Zostavax	
	Demographics	Yes	No
Region	North Central/Midwest	4689 32.77%	9619 67.23%
	Northeast	3462 30.17%	8012 69.83%
	South	6029 25.84%	17307 74.16%
	West	5215 32.71%	10726 67.29%
Sex	Female	11746 31.64%	25377 68.36%
	Male	7649 27.38%	20287 72.62%
Race	White	17449 32.38%	36437 67.62%
	Asian/Indian Asian	736 26.7%	2023 73.3%
	Black/African American	1072 13.73%	6736 86.27%
	Alaskan Native/American Indian	138 22.77%	468 77.23%
Education	Never Attended	39 10.86%	320 89.14%
	Some Schooling No High School Diploma	1679 15.6%	9081 84.4%
	High School Graduate/GED or Equivalent	4737 26.39%	13213 73.61%
	Some College/AA Degree	5650 31.58%	12242 68.42%
	Bachelor's Degree	3771 37.11%	6390 62.89%
	Master's, Professional or Doctoral Degree	3519 44.34%	4418 55.66%
Poverty	At or Above Poverty Threshold	18302 31.9%	39068 68.1%
	Below Poverty Threshold	1093 14.22%	6596 85.78%

Table 8 combines many variables that are key to the analysis. A higher percentage (30.7%) of people who have a usual source for medical care such as a primary care physician (PCP) received Zostavax, while only 10.99% of people without a usual source of care received it. The next variable suggests if the person is against the vaccine altogether: anti vax seniors will not receive Flu Shot. The results show that 38.82% of people who received Flu Shot also received the Shingles Vaccine, compared to 14.04% of people who did not receive Flu Shot in the past 12 months. Of those who received the Tetanus shot, 37.12% received Zostavax as well while only 19.45% of people who did not receive a Tetanus Shot received the Shingles vaccine. As Shingles vaccinations are not fully covered by Medicare, I added a variable to see if a higher percentage of people with private health insurances received Zostavax: 33.8% of people covered by private health insurance answered "yes" when asked if they ever received Shingles vaccination compared to 25.07% of the people not covered by private insurance. Regarding internet literacy. 39.57% of those who looked up health information on Internet in the past 12 months received the Shingles vaccine vs. 24.53% of people who did not look up health information on Internet.

Figure 8 provides a visualization of how differences in age, region and poverty status are associated with vaccination against Shingles. The percentage of people vaccinated against Shingles increases in all regions until the age of 70 and then decreases until 85. The big increase at age 85 can be the result of more physician recommendations for older seniors. It may also reflect lower life expectancy among groups less likely to accept vaccinations, such as people of color.

Table 8: Zostavax, Usual Place for Medical Care, Vaccine Belief, Private Health Insurance and Internet Literacy in numbers.

		Zostavax	
		Yes	No
Has Usual Place for Medical Care	Yes	19070 30.7%	43033 69.3%
	No	325 10.99%	2631 89.01%
Had Flu Shot Vaccine in the Past 12 Months	Yes	16075 38.82%	25334 61.18%
	No	3320 14.04%	20330 85.96%
Had Tetanus Shot in the Past 10 Years	Yes	14160 37.12%	23985 62.88%
	No	5235 19.45%	21679 80.55%
Covered by Private Health Insurance	Yes	11936 33.8%	23372 66.2%
	No	7459 25.07%	22292 74.93%
Looked Up Health Information on Internet, Past 12 Months	Yes	9034 39.57%	13794 60.43%
	No	10361 24.53%	31870 75.47%

6.2 Bivariate Logistics Regression

After looking at the big picture, I performed a Bivariate Logistics Regression to look at the odds

ratios and see what separate impact each independent variable has on the dependent variable

(Shingles Vaccination Rate). All of the variables had a P value of less than 0.0001. In Region

variable I took South as a reference. People from North Central/Midwest region were 1.390

times more likely to receive Shingles vaccination versus people from South region. The odds

ratio is highest in the West (1.402) while it is lowest in Northeast (1.233). For the Sex variable

the reference category was Male. Females were 1.205 times more likely to receive Zostavax than
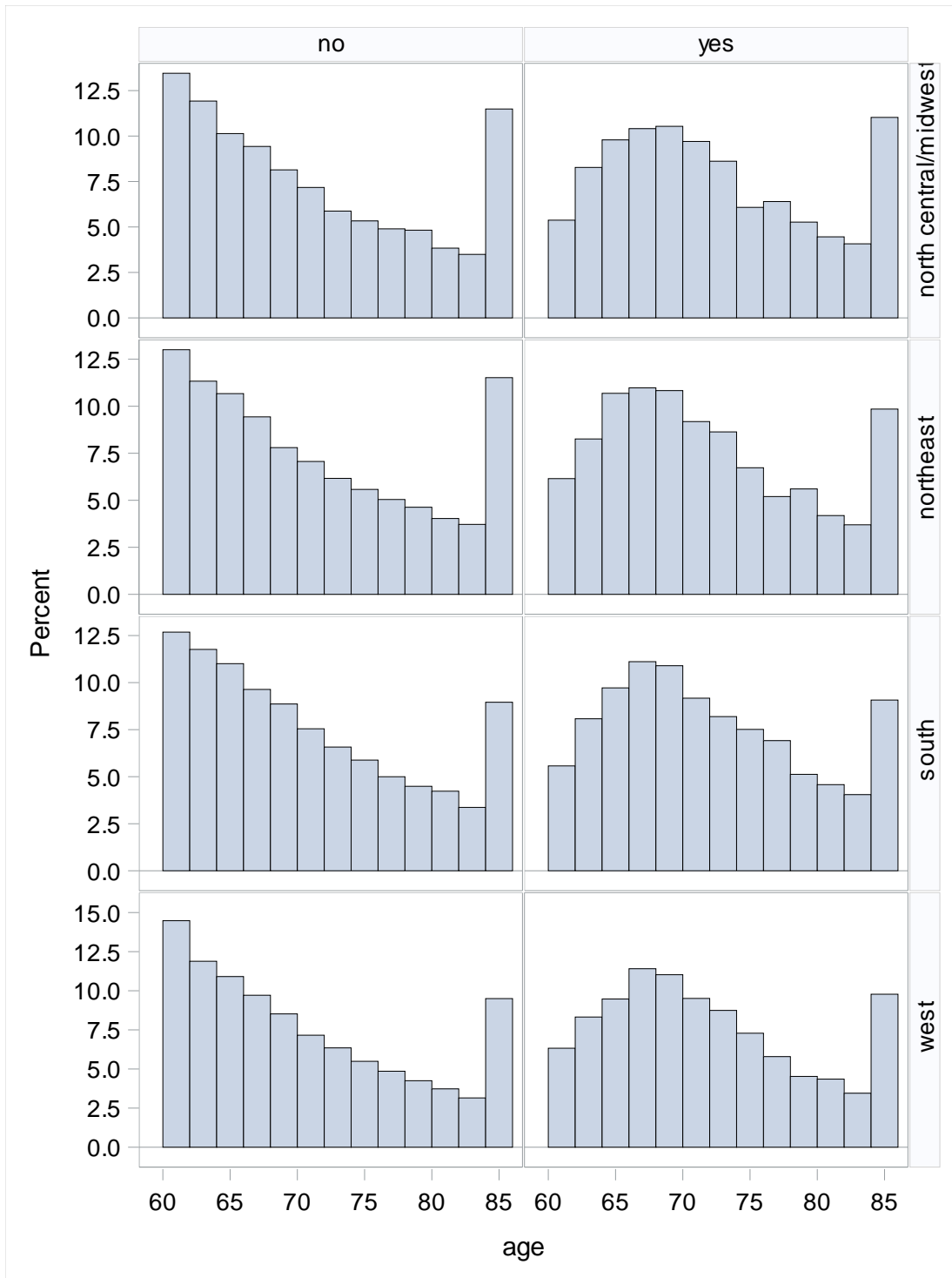
Figure 8: Visualization of Shingles Vaccination Percentage by Age, and Region.

Males. Regarding the Race variable, Black/African American is used as a reference. Compared to Black/African American respondents, all three of the other included races are more likely (Alaskan Native or American Indian 1.895, Chinese 1.835, White 2.962) to receive the Shingles vaccine. Whites are almost three times more likely to receive the Zostavax vs Blacks/African Americans.

For the Education variable, Never Attended/No Schooling was taken as a reference and odds ratios increase with each increase in education level. While people with some schooling but no high school diploma are 1.530 times more likely to receive the Shingles vaccine, people with Master's, Professional or Doctoral Degrees are 7.467 times more likely to receive the Zostavax. For the Poverty variable, below poverty threshold was taken as a reference. People who live at or above poverty threshold are 2.837 times more likely to receive the vaccine than people who live below poverty threshold.

The results of the Health Status variable were surprising for me as I expected the odds ratios to be opposite of what the results indicated. I expected a higher odds ratio for the "in poor, fair health" categories as I believed that people with chronic conditions see their doctors more. When one sees a doctor more frequently the doctor has more opportunity to discuss/recommend vaccinations and their benefits. However, the results were different. In this variable Poor Health was taken as a reference. People who reported themselves to have excellent health were 2.492 times more likely to receive the Shingles vaccination vs. people who reported themselves in poor health.

Table 9: Bivariate Logistics Regression with Zostavax – Variables with Big Impact

Variables		Odds Ratio	P
Region	North Central/Midwest	1.390	
	Northeast	1.233	<0.0001
	South	reference	
	West	1.402	
Sex	Female	1.205	<0.0001
	Male	reference	
Race	Alaskan Native or American Indian	1.895	
	Black/African American	reference	<0.0001
	Chinese	1.835	
	White	2.962	
Education	Never Attended	reference	
	Some Schooling No High School Diploma	1.530	<0.0001
	High School Graduate/GED or Equivalent	3.132	
	Some College/AA Degree	4.274	
	Bachelor's Degree	5.552	
	Master's, Professional or Doctoral Degree	7.467	
Poverty	At or Above Poverty Threshold	2.837	<0.0001
	Below Poverty Threshold	reference	
Health Status	Excellent	2.492	<0.0001
	Very Good	2.348	
	Good	1.683	
	Fair	1.181	
	Poor	reference	
Has Usual Place for Medical Care	Yes	3.379	<0.0001
	No	reference	
Medical Care Delayed Due to Cost, Past 12 Months	Yes	reference	<0.0001
	No	1.917	
Had Flu Shot Vaccine in the Past 12 Months	Yes	3.790	<0.0001
	No	reference	
Had Tetanus Shot in the Past 10 Years	Yes	2.597	<0.0001
	No	reference	
Looked Up Health Information on Internet, Past 12 Months	Yes	2.367	<0.0001
	No	reference	

People who have a usual source for medical care were 3.379 times more likely to receive the Shingles vaccination vs. people who did not have a usual place for medical care. Participants who did not delay medical care due to cost were 1.917 times more likely to receive Zostavax vs people who delayed medical care due to cost in the past 12 months. People who received a Flu Shot in the past 12 months were 3.790 times more likely to receive the Zostavax vs people who did not receive Flu Shot in the past 12 months. The results of the Tetanus Shot were similar: people who received Tetanus Shot in the last 10 years were 2.597 times more likely to receive Zostavax.

Another variable with a high odds ratio is "Looked Up Health Information On Internet in the Past 12 Months," an attempt to assess if computer literacy has an effect on the Shingles vaccination rate. People who looked up health information on Internet were 2.367 times more likely to receive the Shingles vaccine vs people who did not look up information on Internet.

6.3 Multiple Logistics Regression

After the Bivariate Logistics Regression, I conducted a Multiple Logistics Regression to see if the results differed when the independent variables are analyzed together and not one by one as in the former analysis. I included the results of Tetanus Shot analysis to see if they can support the results of the Shingles vaccination. Any odds ratio that is close to one means that a one unit increase in the independent variable increases the odds of the dependent variable by one unit, which does not change anything and does not give us correlation. Marital Status, Main Racial Background, Family Home Ownership, Scheduled Appointment with Health Care Provider on Internet (Shingles), Has any Medicaid/Other Public Assistance (Shingles), Covered by Private

Health Insurance (Shingles), Covered by Military Health Insurance and Has Any Activity

Limitation variables have odds ratios close to one.

Table 10: The Results of the Multiple Logistics Regression – Comparing Odds Ratios from Shingles and Tetanus Analysis.

Vaccination Rate Factor	Shingles		Tetanus	
	Odds Ratio	P	Odds Ratio	P
Region	1.02	0.025*	1.02	0.045*
Sex	1.42	<0.0001***	0.75	<0.0001***
Marital Status Including Living with Partner	0.98	<0.0001***	0.97	<0.0001***
Main Racial Background	0.99	<0.0001***	0.99	<0.0001***
Educational Attainment	1.18	<0.0001***	1.12	<0.0001***
Above or Below Poverty Threshold	0.71	<0.0001***	0.89	0.001**
Family's Home Owned or Rented	0.98	<0.0001***	0.99	0.014*
Health Status	0.88	<0.0001***	1.007	0.412
Scheduled Appointment with Health Care Provider on Internet, Past 12 Months	1.05	0.28	1.27	<0.0001***
Communicated with Health Care Provider Using Email, Past 12 Months	1.46	<0.0001***	1.55	<0.0001***
Looked Up Health Information on Internet, Past 12 Months	1.20	<0.0001***	1.39	<0.0001***
Has Usual Place for Medical Care	1.51	<0.0001***	1.58	<0.0001***
Medical Care Delayed Due to Cost, Past 12 Months	0.75	<0.0001***	1.26	<0.0001***
Had Flu Shot Vaccine In the Past 12 Months	3.32	<0.0001***	1.69	<0.0001***
Delayed Care Because Lacked Transportation	0.89	0.13	1.34	<0.0001***
Has any Medicaid/Other Public Assistance	0.94	0.13	1.11	<0.0001***
Covered by Private Health Insurance	1.04	0.03*	1.16	<0.0001***
Covered by Military Health Insurance	1.02	<0.0001***	1.02	<0.0001***
Had Tetanus Shot in the Past Ten Years/ Had Zostavax	1.83	<0.0001***	1.83	<0.0001***
Has Any Activity Limitation	1.00	0.47	0.901	0.204

*P<0.05; **P<0.01; ***P<0.001.

The variables with the biggest odds ratios are Had Flu Shot Vaccine in the Past 12

Months with 3.32 (Shingles), 1.69 (Tetanus) and Had Tetanus Shot in the Past Ten Years/Had

Zostavax with 1.83. One unit increase in Had Flu Shot Vaccine variable (No to Yes) increases the odds of getting Zostavax/Tetanus Shot by 3.32 times (Shingles) and 1.69 times (Tetanus). Sex had different effect on Shingles and Tetanus vaccination rates. In Shingles analysis being a female increases the odds of getting a Shingles Vaccine by 1.42 times vs in Tetanus analysis being a female decreases the odds of getting a Tetanus Shot by 0.75 times. We will discuss this difference in the next chapter.

After Bivariate Logistics Regression analysis, I was not satisfied with the results of the Multiple Logistics Regression Analysis. The variables that I expected to have bigger odds ratios were either too close to one or insignificant.

6.4 Multiple Logistics Regression with Reference Category

To look more deeper into independent variables and their individual effect on the dependent variable, I have performed Logistics Regression with reference category. Table 11 summarizes the results of the analysis and states the reference category in each variable. In Region the reference category is South: people in North Central/Midwest region are 1.167 times more likely to receive Shingles vaccine vs. people in the South. The West region's odds ratio (1.237) shows that compared to South; people living in the West of the United States are 1.237 times more likely to receive Shingles vaccine. In Multiple Logistics Regression the odds ratio of Region was too close to one (1.02).

In Sex variable females are 1.426 times more likely to receive Shingles Vaccine than males. Race variable had an odds ratio of 0.99 in the previous analysis, however in this analysis all of the categories show high odds ratios. Alaskan Natives are 1.426 times more likely to

receive Shingles vaccine than Black/African Americans. While Asians are 1.587 times more likely to receive Shingles vaccine than Black/African Americans, Whites are 1.801 times more likely to receive it compared to Black/African Americans.

Having a reference category improved the odds ratios of Education variable. As expected, the odds ratios are increasing with an increase in education level. While High School Graduates are 1.699 times more likely to receive Shingles vaccine than people with no schooling (Never Attended), people with Master's, Professional or Doctoral Degrees are 2.715 times more likely to receive the vaccine.

People who live at or above the poverty threshold are 1.244 times more likely to receive Shingles vaccine vs people who live below the poverty threshold. Delayed Care Because Lacked Transportation, Has Any Medicaid/Other Public Assistance, Scheduled Appointment with Health Care Provider on Internet, Past 12 Months variables are insignificant. While Has Any Activity Limitation variable was insignificant in the previous analysis, it is significant in this one. People who are not limited in any way are 1.117 times more likely to receive the Shingles vaccination vs people who are limited in some way. Having military health insurance increases the odds of getting Shingles vaccine by 1.358 times compared to people without military health insurance. In both of the analysis Had Flu Shot Vaccine in the Past 12 Months and Had Tetanus Shot in the past 10 Years had big odds ratios. People who had Flu Shots in the last 12 months were 3.118 times more likely to get Shingles vaccination. Furthermore, people who had Tetanus Shots in the past 10 years were 1.884 times likely to receive Zostavax.

Table 11: The Results of Multiple Logistics Regression with Reference Category

		Odds Ratio	P
Region	North Central/Midwest vs South	1.167	<0.0001***
	Northeast vs South	1.065	0.0328*
	West vs South	1.237	<0.0001***
Sex	Female vs Male (reference)	1.426	<0.000***1
Race	Alaskan Native vs Black/African American	1.426	0.0024**
	Asian vs Black/African American	1.587	<0.0001***
	White vs Black/African American	1.801	<0.0001***
Education	Some Schooling vs Never Attended	1.205	0.3116
	High School Graduate/GED or Equivalent vs Never Attended	1.699	0.0038**
	Some College/AA Degree vs Never Attended	1.935	<0.0001***
	Bachelor's Degree vs Never Attended	2.220	<0.0001***
	Master's, Professional or Doctoral Degree vs Never Attended	2.715	<0.0001***
Poverty	At or Above Poverty Threshold vs Below Poverty Threshold (reference)	1.244	<0.0001***
Medical Care Delayed Due to Cost, Past 12 Months	No vs Yes (reference)	1.186	0.0046**
Delayed Care Because Lacked Transportation	No vs Yes (reference)	1.101	0.2263
Has any Medicaid/Other Public Assistance	No vs Yes (reference)	0.978	0.6083
Covered by Military Health Insurance	Yes vs No (reference)	1.358	<0.0001***
Had Flu Shot Vaccine in the Past 12 Months	Yes vs No (reference)	3.118	<0.0001***
Had Tetanus Shot in the Past 10 Years	Yes vs No (reference)	1.884	<0.0001***
Has Any Activity Limitation	Not limited vs limited (reference)	1.117	<0.0001***
Scheduled Appointment with Health Care Provider on Internet, Past 12 Months	Yes vs No (reference)	1.015	0.7463
Communicated with Health Care Provider Using Email, Past 12 Months	Yes vs No (reference)	1.395	<0.0001***
Looked Up Health Information on Internet, Past 12 Months	Yes vs No (reference)	1.271	<0.0001***

*P<0.05; **P<0.01; ***P<0.001.

People who communicate with their health care providers using email in the past 12 months were 1.395 times more likely to receive Zostavax vs people who did not communicate with their health care provider using email. Also, people who looked up health information on Internet in the past 12 months were 1.271 times more likely to receive Zostavax vs people who did not look up health information on Internet. The table summarizes the main findings of the logistics regression analysis with reference category. The results are more detailed and more explanatory than the previous logistics regression.

Table 12: Hosmer and Lemeshow Goodness-of-Fit Test.

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
15.0058	8	0.0590

Table 12 is the result of Hosmer and Lemeshow Goodness-of-Fit Test. My analysis has a sample size of over 62 thousand observations. Kramer et al. (2007) mention that in analysis with large sample size P value can be smaller than desired. Generally, large P values indicate a better fit of the model, but this is difficult to obtain with a large sample size. Still, based on the result, we fail to reject the null hypothesis and our model fits the data.

Figure 8 shows us the Receiver Operating Characteristic Curve (ROC Curve) and Area Under the Curve (AUC) results. According to the AUC our predictions are 76.25% correct which is not perfect but acceptable.
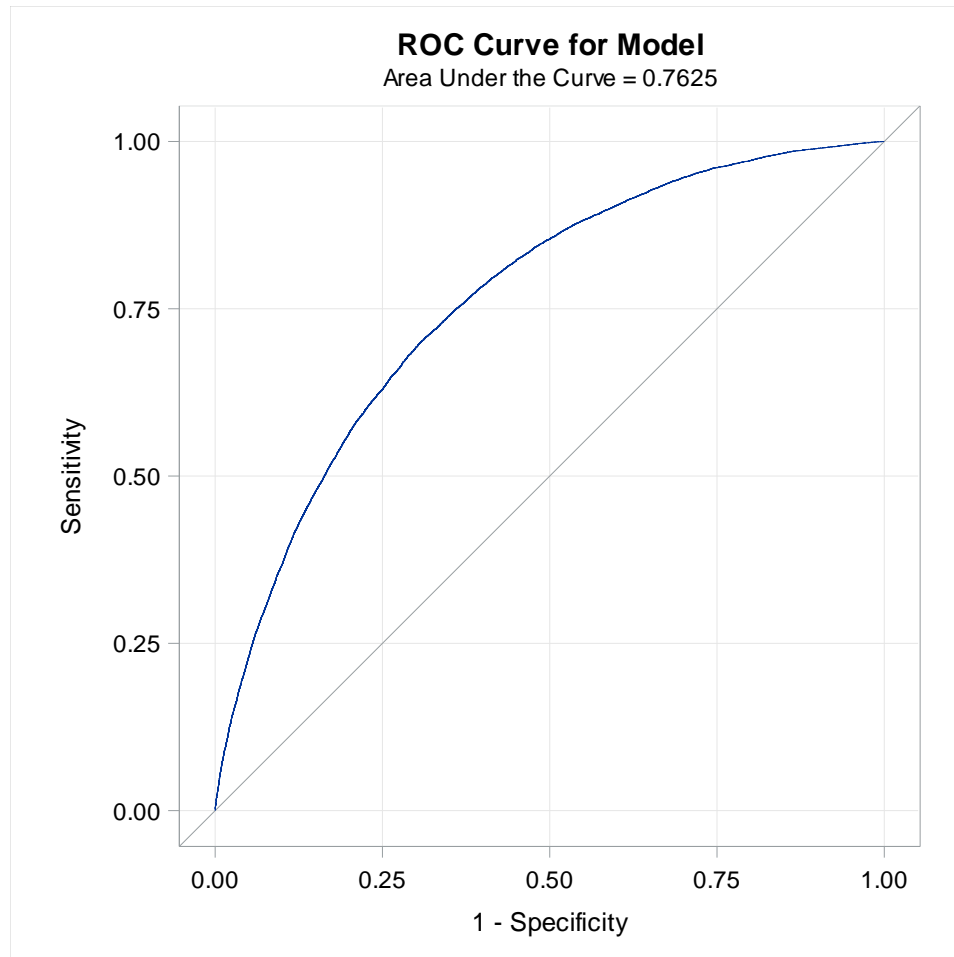
Figure 9: A Receiver Operating Characteristic Curve (ROC curve) and Area Under the Curve Results.

CHAPTER 7

DISCUSSION

In the Multiple Logistics Regression Tetanus vaccination analysis, among 20 available independent variables, two were insignificant and while 11 had a positive effect on the vaccination rate, two of them had a negative effect and five of them had weak effect on the vaccination rate. A weak effect means that one unit increase in the independent variable have the same effect on both of the dependent variable answer options (Yes and No). All the variables with the odds ratio that falls between 0.91 and 1.09 have been considered as the variables with a weak effect.

In the Multiple Logistics Regression Shingles vaccination analysis, among 20 available independent variables, four were insignificant, six variables had weak effect, four variables had significant negative effects and seven of the variables had significant positive effects on the Shingles vaccination rate.

There was one variable that was insignificant in both Multiple Logistics Regression Tetanus and Shingles vaccination analysis: LANY which is short for "has any activity limitation". We were expecting this variable to have a negative effect on both of the dependent variables. Having any kind of activity limitation may affect the individual's capacity to go to the regular medical check-ups and thus a person with such limitations may see his/her primary care physician less often than somebody who does not have any activity limitation. Additionally, because of short shelf life, most of the physicians do not have Zostavax in stock which will require the physician to refer his/her patient to the pharmacy that has the vaccine in stock. For an individual with activity limitation, this travel is another burden which may result in the

individual to decline or postpone getting the vaccine. The insignificance of the variable in both of the analysis could have proved the idea wrong has it not been significant in the Multiple Logistics Regression with Reference Category analysis. People with no limitations are 1.117 times more likely to receive Zostavax vs people with some limitations.

I have assumed that the health status of a senior will have a significant effect on the Tetanus and Shingles vaccination rate. I had two variables in mind: LANY and HEALTH. I hypothesized that while the activity limitation (LANY) has a negative effect on the dependent variable, the health status of a senior (HEALTH) has a positive effect on the dependent variable. If a senior has a chronic condition/disease, he/she may need more checkups than a senior without any chronic conditions. It can result in more information being transferred from the physician's office to the patient; more recommendations and follow ups about the recommended vaccinations. However, HEALTH variable was insignificant in Tetanus vaccination analysis while it has a negative effect in Shingles vaccination analysis with an odds ratio of 0.882. The HEALTH variable had weak association with Shingles vaccination rate in the Logistics Regression with Reference Category analysis. The Tetanus vaccination has been around for many decades, but the Shingles vaccination has been around for less than 15 years. Getting information, more recommendations, being followed up by the physician may not be very important triggers for getting a Tetanus vaccination as the Tetanus vaccination is not a new one. In comparison, the Zostavax and Shingrix need more introductions to the seniors. One thing to discuss is the negative effect of the variable while I hypothesized a positive one. The Shingles vaccination analysis shows that one unit increase in the HEALTH variable (the variable has been coded with increasing numbers as the senior's health status gets worse) decreases the odds of

getting a Zostavax shot by 0.882 units. This result proves my first hypothesis wrong altogether. The only reason I can think of is unavailability of the Shingles vaccination in most of the physicians' offices which would require a senior to travel to a pharmacy which would be a burden for the seniors with chronic diseases. Additionally, seniors with chronic health conditions, especially with disabilities are more likely to be low income and socially isolated.

I have used the REGION variable as a part of the demographic variables. I thought that more urban regions with more educated people will have a positive effect on both of the vaccinations. However, the variable had a weak association with the vaccination rate (1.021) in the Shingles and Tetanus vaccination analysis in the first logistics regression I have performed. However, with the reference category the picture has changed. Comparing South to other regions has shown that all three regions are more likely to receive Shingles vaccinations vs South. Although the odds ratio of Northeast vs South was not as big as I expected (1.065), people in North Central/Midwest are 1.167 times more likely to receive the Shingles vaccine while people in West are 1.237 times more likely to receive the vaccine compared to people living in the South. These results can be a direct result of average education level, poverty level and race distribution in each region. However, we cannot say it for sure before further analysis.

RACEA variable which was another variable to measure the demographics of the seniors did not have much effect in the first logistics regression analysis with the odds ratio of 0.998 for both Tetanus and Shingles vaccination rates. However, when I performed the analysis with the reference category Race variable gave me results I expected. Black/African American category was taken as a reference and compared to Alaskan Native/Native American, Asian, and White categories. Compared to other three categories, Black/African Americans were less likely to

receive the Shingles vaccination. Whites were 1.801 times more likely to receive the Zostavax compared to Blacks/African Americans. The odds ratios are smaller in Asian and Alaskan Native categories compared to Whites but Alaskan Natives are 1.426 times more likely to receive the Shingles vaccination while Asians are 1.587 times more likely to receive it.

In the first logistics regression, the SEX variable has a negative odds ratio of 0.74 in the Tetanus vaccine analysis which means that one unit increase in sex, where Male is coded as 0 and Females is coded as 1, decreases the odds of getting the Tetanus shot. Although I was expecting a positive odds ratio as I believed that Females are more likely to get their recommended vaccinations, the current result may be because of the type of the vaccination. A lot of farmers and people working in construction business are more likely to get the vaccination and these occupations are mostly dominated by men rather than women. My predictions were true in the Shingles analysis with the SEX variable odds ratio of 1.417 which is a strong positive effect. One unit increase in the SEX variable (Men to Women) increases the odds of getting the Shingles vaccination by 1.417 units. The results were consistent in the analysis with reference category. Females were 1.426 times more likely to receive Shingles vaccination than males. Usually women seek medical help, follow the current vaccination recommendation more often than men; therefore, being a woman increases the odds of getting a vaccination. This prediction was not true for the Tetanus vaccination probably because of the type of vaccination.

The MARSTCOHAB variable has an odds ratio of 0.97 in the Tetanus vaccination analysis and 0.984 in the Shingles vaccination analysis. The variable did not give us the expected results in the analysis with the reference category. Although both of the variables have negative odds ratios (less than 1), none of them has a big effect on the dependent variable. I assumed that

64

being married or living with a partner would increase the odds of getting a Tetanus shot and Shingles shot as spouses and partners tend to take care of each other and motivate each other to seek medical help when any of them needs one. As a result, I was expecting an odds ratio a lot smaller than 1. However, in this case I cannot definitely say that this variable and Tetanus shot/Shingles shot has a strong correlation.

My second hypothesis which stated that demographics of a senior can affect the vaccination rate is partially true: the SEX variable had strong effect on both of the vaccination rates; the Region variable was insignificant in the Tetanus vaccination analysis but was significant in the Shingles vaccination analysis, although the effect was not as big as expected in the first analysis, the results were as expected in the analysis with the reference category. The RACEA variable gave me clearer and more detailed results in the second analysis while MARTSCOHAB did not give

The DELAYTRANS variable which stands for "delayed care because lacked transportation" has a strong positive odds ratio in the Tetanus vaccine analysis while it is insignificant in the Shingles vaccine analysis. When we analyzed the variable with a reference category, the results have not changed. Delaying medical care due to lack of transportation can mean that a senior has a financial struggle which could have resulted in delaying or postponing getting the vaccinations that require out of pocket fees. Additionally, as most of the physicians do not stock Zostavax in their offices, the senior who had a difficulty to visit his/her doctor due to the lack of transportation will have another difficulty trying to get to the pharmacy where the vaccine is stocked. Therefore, I was expecting a big effect with Shingles vaccination rate. However, the variable has a strong positive odds ratio (1.341) in the Tetanus analysis which I

cannot explain. This positivity may be due to the vaccine type but I could not find an argument that would explain it.

The DELAYCOST variable gave expected results in the analysis with the reference category. People who did not delay medical care due to cost in the past 12 months were 1.186 times more likely to receive the Shingles vaccination. This is meaningful as the Shingles vaccination has out of pocket cost to seniors. If they delayed medical care due to cost, it is possible that they can delay receiving vaccination that requires out of pocket fees. Additionally, if they do not go to the physician as often as they need, they are not able to get the latest recommendations and their physicians cannot follow up with them about the recommended vaccinations.

The HIPUBCOVE variable which stands for "Has any Medicaid/other public assistance" is another variable to measure the financial factors affecting the vaccination rates in seniors. There are explanations for both positive and negative odds ratios. If the odds ratio is positive, we can explain it by saying that any kind of medical public assistance would help to ease the burden of out of pocket costs for Tetanus and Shingles shots. This would have resulted in more people getting the vaccines. The negative correlation could have been explained as seniors who are getting Medicaid or other public assistance are in bigger financial struggles than other seniors. Bigger financial struggles would mean that even a small out of pocket cost could be a burden which as a result will lead to delaying getting the vaccines. In the Shingles vaccine analysis, this variable is insignificant and in the Tetanus vaccine analysis, the variable has a positive odds ratio of 1.112. The positive odds ratio in the latter analysis is reasonable as the out-of-pocket cost of the Tetanus shot is not as big as that of Shingles shot, therefore Medicaid or any kind of medical

public assistance can cover most of the out-of-pocket fees. In the analysis with the reference category this variable was insignificant.

The HIPRIVATEE variable which stands for "covered by private health insurance" has a weak accosiation (1.04) in the Shingles vaccine analysis while it has a bigger positive odds ratio (1.162) in the Tetanus vaccine analysis. I was expecting the opposite: stronger positive odds ratio for the Shingles and not so big positive ratio for the Tetanus shots. They still do have a positive odds ratio that I was expecting because having a private health insurance can cover most, if not all, of the out of pocket costs, which in result, can increase the odds of getting the Shingles and Tetanus shots. The reason for the two different odds ratios can be the age of the vaccinations. The Zostavax is comparably new vaccination and the information factor and financial factors may have the same effect on the vaccination rate. The Tetanus shot has been around for decades and information factor may not have as big effect as the financial factor has. Therefore, the variable had more positive effect on the Tetanus vaccination rate. Having private health insurance coverage had weak association with Shingles vaccination rate in Zostavax analysis with reference category.

The HIMILITE variable which stands for "covered by military health insurance" does have weak positive odds ratio of 1.019 for the Shingles vaccine analysis and 1.023 for the Tetanus vaccine analysis in the first logistics regression. The odds ratio in the first Shingles analysis was not as high as I expected but the regression with reference category showed a better result. People who were covered by Military health insurance were 1.358 more likely to receive the Zostavax compared to people without one.

The OWNERSHIP variable which stands for "family's home owned or rented" had an expected negative odds ratio in the first analysis. In the analysis "owned or being bought" variable was coded as 0 and "Rented"/ "Other Arrangements" were coded as 1. One unit in this variable decreased the odds of getting the Tetanus vaccine by 0.995 units and getting the Shingles vaccine by 0.98 units. The weak negative accosiation may be because of housing prices in rural and urban areas. A senior with a good income may not purchase a house in San Francisco area as easy as a senior living in a small town of Texas. In the second analysis with the reference category I have tested "owned" vs the other two categories ("rented" and "other arrangements"). People who owned a house were 1.266 times more likely to receive Shingles vaccination compared to people who rent or have other arrangements.

The POORYN variable which stands for "above or below poverty threshold" was coded as 0 for at or above the poverty threshold and as 1 for below the poverty threshold. I was expecting one unit increase in the variable to decrease the vaccination rates. The first analysis gave me expected negative odds ratios of 0.896 for the Tetanus analysis and 0.707 for the Shingles analysis. As we can see, the variable has bigger effect on the Shingles vaccination which, I believe, is the result of high out-of-pocket costs which is much higher than that of Tetanus vaccination. The difference of 0.19 points in the two odds ratios can indicate the bigger importance of financial factors for the Shingles vaccination rate. When a senior is under poverty, an out-of-pocket cost that can be more than $100 can make a senior question if he/she needs the vaccination. In the analysis with the reference category, the results were similar: people who lived at or above the poverty threshold were 1.244 times more likely to receive the Shingles vaccination vs people who lived under the poverty threshold.

In my third hypothesis, I hypothesized that financial factors including income, home ownership and extra medical insurance coverage can affect the vaccination rate in seniors. Better financial status with a good household income, owned home and additional medical insurance coverage can increase the Tetanus and Shingles vaccination rate. Although some of the variables did not give us as big effects as we expected, the effect of the financial factors over the vaccination rates cannot be denied. This effect can be minimized by funding the Shingles vaccine so that people who rethink receiving the vaccine because of high out of pocket cost can be decreased in numbers.

There were three variables to measure the internet literacy of the seniors and see the variables' effect on the vaccination rates. I predicted to have positive odds ratios for all three variables in both of the analysis. The first variable, PCAPPTHPYR stands for "scheduled appointment with healthcare provider on Internet, past 12 months." Strangely, this variable is insignificant in the Shingles vaccine analysis while it has a positive odds ratio of 1.269 for the Tetanus vaccination rate in the first logistics regression analysis. This variable was insignificant in the second logistics regression I performed. The second variable, PCEMAILHPYR which stands for "communicated with healthcare provider using Email, past 12 months" has the largest positive odds ratios among the three variables in the first analysis: 1.55 for Tetanus and 1.457 for Shingles. In the analysis with the reference category, people who communicated with their health care provider using email in the past 12 months were 1.395 times more likely to receive the Shingles vaccination. Communicating with your physician through email increases the chance of getting accurate information, recommendations, and follow ups from the physician that the senior trusts. However, being able to search for health information on internet can also benefit

the Shingles vaccination rate. PCLOOKHELYR variable which stands for "looked up health

information on Internet, past 12 months" does not have as large positive odds ratio as the

PCEMAILHPYR has: 1.39 for Tetanus and 1.198 for Shingles in the first analysis. And in the

second analysis the odds ratio was 1.271 which means that people who looked up health

information on internet were 1.271 times more likely to receive the Zostavax vs people who did

not. Looking at the difference in odds ratios between PCEMAILHPYR and PCLOOKHELYR

we can assume that the information and recommendation coming from a trusted healthcare

provider has bigger effect on the vaccination rate of seniors than looking up health information

on the Internet.

In the first analysis, the USUALPL variable which stands for "having a usual place for

health care" has a positive odds ratio of 1.582 for the Tetanus and 1.507 for the Shingles vaccine

which indicates a strong positive effect this variable has on the vaccination rate in seniors. In the

analysis with the reference category, I have taken "yes, have regular place for health care"

category as a reference. Compared to people who have regular place for health care, people who

do not have a usual place for health care are 0.542 times more likely to have the Shingles

vaccination. Having a usual place for health care will ensure that a senior receives appointment,

recommended vaccinations and follow up reminders from them. The senior will have a physician

that he/she trusts which can affect the vaccination rate positively. If one does not have a usual

place for health care and researches about the recommended vaccinations and decides to get

them, he/she will have to look for a place to get them which may take time. The extra time

he/she is looking for a pharmacy or a physician's office can delay getting the vaccination. If one

does not have a usual place for health care where he/she can get accurate information about the

efficacy and the safety of the vaccination, he/she may be tricked by the false or incomplete information on the internet. Additionally, seniors without usual place for health care are more likely to receive care in an emergency departments or urgent care facilities where vaccination follow ups are less likely. Therefore, the big positive effect of this variable was expected.

The EDUC variable which stands for the highest education level of the senior has positive odds ratios in the first analysis: 1.12 in Tetanus and 1.182 in Shingles. Having greater level of education should increase the ability of a person to differentiate between good and bad healthcare choice and make informative decisions informative conversation/discussion with their physician. Both of the vaccinations have been proven to be safe and effective in preventing the diseases. Additionally, the education level can also be connected to the financial factor as having a higher education level increases the odds of having a higher income. Although the positive odds ratio was expected, the magnitude of the effect was expected a lot higher than the current positive effect. This expectation was met in the second analysis with the reference category. The lowest odds ratio belonged in the comparison between "High School Graduate/GED or Equivalent" vs "Never Attended" (1.699). In this analysis we can clearly see that compared to the reference group who never attended school, odds ratios are getting higher with each increase in education level.

In my last hypothesis I predicted that the education status, internet literacy and having a usual place for medical care would have positive effects on the Tetanus and Shingles vaccination rate in seniors. Although one of the variables measuring internet literacy was not significant in the Shingles vaccination analysis, all other variables had big effect on the vaccination rate. The biggest positive odds ratio belonged to the USUALPL variable which indicates that having a

71

usual place for healthcare is more important than the education level or the internet literacy of the senior. Being able to get the most up to date and the most accurate information about the vaccinations affects the vaccination rates significantly.

The next two variables VACFLUSH12M and SHOTZOSTEV for the Tetanus vaccine analysis and VACFLUSH12M and SHOTET10Y for the Shingles vaccine analysis can help us understand the senior's overall belief in vaccinations. The results of the first analysis show that getting a flu shot every 12 months increases the odds of getting the Tetanus vaccination by 1.694 units and Shingles vaccination by 3.317 units. In the second Shingles analysis with a reference category, the results were similar: 1.884 for Tetanus and 3.118 for Flu Shot. The high odds ratio for the Shingles vaccination indicates that if the senior decides to get the Shingles, he/she is already informed about the vaccinations altogether. In the Tetanus vaccine analysis, one unit increase in SHOTZOSTEV (Zostavax) increases the odds of getting the Td/Tdap by 1.831 units. The odds ratio is almost identical in the Shingles vaccine analysis: one unit increase in the SHOTET10Y (Tetanus) increases the odds of getting the Shingles vaccine by 1.835 points. Getting one of the recommended vaccinations can increase the odds of getting the others.

There are several factors that are likely to affect the low Shingles vaccination rate: new vaccine – less information, high out of pocket cost, accessibility and trust. Another reason can be seniors with compromised immunity who cannot take Zostavax but this problem has been solved with the new Shingrix vaccine which is safe for everybody. To improve the rate of Shingles vaccination, recommending vaccine, providing accurate information about the safety and the efficacy, following up if the senior had his/her recommended vaccine are crucial.

CHAPTER 8

CONCLUSION

When I planned to do this research, there were not many studies done about the Shingles vaccination and there was only one vaccination available: Zostavax. Two years ago, another vaccination against the Herpes Zoster, Shingrix, was introduced which had better efficacy, better safety and additionally was not a live attenuated vaccine. Zostavax is not used in the United States as of November, 2020. At the moment, the only vaccine against Shingles in the US is Shingrix. With the introduction of Shingrix, research about the Shingles has increased. Researchers were looking at the burden of the disease from different points and recommending a better vaccination policy. In the beginning, I had planned to do a mixed-method study which would have analyzed the supply and the demand side of the Zostavax and understand factors affecting the low vaccination rate in seniors from both sides of the coin. Unfortunately, due to the state health department officials' and medical doctors' unavailability, I had to change my research and focus on the demand side. I have decided to analyze the demand side of both Tetanus and Shingles vaccinations and compare the results.

Why Tetanus? The Tetanus vaccine has been around for decades while the Zostavax has been released less than 15 years ago. Comparing data from the vaccine that has been known for years, I believed, could help to understand the factors affecting the Shingles vaccination rate better. Additionally, the Tetanus vaccination like Zostavax, is not covered by the Medicare Part B. In order to get the vaccination for free and avoid the out-of-pocket cost, a senior should have an alternative insurance whether it is a private, military or public assistance insurance. Although the price of the Td/Tdap is not as high as Zostavax and Shingrix, it can still affect a senior's

decision to get it when he/she is used to get preventative care for free. The significance of this research comes from the comparison between a vaccine that has been around for decades and a vaccine that has been introduced more than a decade ago.

This research showed that financial factors like income, home ownership and additional insurance coverage affect the vaccination rate positively. Being under poverty decreased the odds of getting a vaccination which was similar in both Tetanus and Shingles analysis. The gender of the senior had different effects in two analysis which could be explained by the farmers and construction workers, who are at more risk of getting the Tetanus, being male dominated industries. The Shingles vaccination does not have such target group as everybody who had varicella is in risk of getting the disease. Some financial factors like DELAYCOST and DELAYTRANS were expected to give some negative odds ratios. However, both of the variables had big positive odds ratios which can indicate that financial factors are more of a concern for the Shingles vaccination than the Tetanus vaccination as the out-of-pocket cost for the Shingles vaccines are almost four times higher than that of Tetanus vaccination.

Internet literacy and having a usual place for healthcare had the largest positive effect on the vaccination rate. Being able to access the information and check the accuracy of the information with your healthcare provider is essential in increasing the vaccination rate. Having additional insurance coverage had positive effect on the Tetanus vaccination rate while it did not affect the Shingles vaccination rate as expected. Another big factor affecting both of the vaccination rates was whether the senior had the Flu Vaccine in the past 12 months. Getting a Flu Vaccine increased the odds of getting both the Tetanus and Shingles vaccines. While getting

the Tetanus vaccine increased the odds of getting the Shingles vaccine, getting the Shingles vaccine increased the odds of getting the Shingles vaccine as well.

In order to increase the vaccination rates, health departments together with physicians should inform elderly about the risks of the disease. The social media, especially Facebook, can be used to reach many seniors. Anti-vaccination movements spread their conspiracy theories through the social media. To decrease the effect of these false information, health departments can create online flyers explaining myths and facts about the vaccination. Information should be brief and easy to understand. After informing the target population about the vaccination, health departments should ensure that the vaccine is widely available and accessible. Lastly, the vaccination should be affordable.

As the world is fighting with COVID-19 outbreak, increasing the COVID vaccination rate is essential to bring the lives of billions of people back to normal. At the moment, the accessibility and availability of the vaccine are two main problems. However, the social media platforms are flooded with false horror stories of people who got the vaccine and experienced seriously bothersome side effects. Reaching out to public through the social media with facts about the vaccination should be health departments' high priority. Increasing awareness of the vaccine safety is crucial in increasing the vaccination rate.

One of the main limitations of my research is analyzing only one side of the equation. In order to understand the problem and find the correct solutions, it is essential to study both sides of the equation: the supply and demand side of the Shingles vaccine. Another limitation is the type of the Zostavax which is a live attenuated virus vaccine. It is not recommended for people with compromised and suppressed immunity. The variable which asked whether the senior had

weak immunity did not have enough data and thus, was not included in the analysis. This may be one of the reasons that the HEALTH variable was insignificant for the Tetanus vaccine analysis but was significant with strong negative odds ratio for the Shingles vaccine analysis. Not including the information about the immunity condition of the senior may have given us less accurate information. This variable would not be important if there were 10 years of Shingrix data available as it does not have any contradictions with the weak immune system.

In order to increase the Shingles vaccination rate Shingrix and Zostavax should be covered by Medicare Part B with zero cost for the customers. The direct financial burden of the disease that fall on Medicare is predicted to be at least $1 billion with another $1 billion loss in productivity. Physicians should be able to get advantage from the vaccine buy-back programs for the expired vaccinations. This would make the vaccine available at every physician office which would encourage health care providers to recommend the vaccine all of the time. There should be information sessions, leaflets with the most up to date information about the vaccine and its efficacy and safety and the explanation of the pain and complications that may result from the disease. Increasing the awareness and easing the seniors' financial burden of getting the vaccine can increase the Shingles vaccination rate in seniors significantly.

When there will be at least 10 years of data for the new Shingrix vaccine, this study can be redone together with the supply side analysis. The new vaccine is more effective and does not present a danger to people with compromised and weakened immunity. These factors alone can show increase in the Shingles vaccination rate in the following years. However, to increase the rate to the aimed 70%, the out-of-pocket cost should be removed or at least, minimized. To understand the factors affecting the Shingles vaccination rate, it is important to look at the supply

side of the equation. What do physicians think about the low Shingles vaccination rate? What do

local and state health officials think can improve the low rate? A study that analyzes both sides

together with the new vaccine can give us clearer picture and more definite answers.

BIBLIOGRAPHY

Akinboosoye, O. E., Taitel, M. S., Grana, J., & Macpherson, C. (2016). Factors associated with Zostavax abandonment. *The American Journal of Pharmacy Benefits*, *8*(4), 84–89. https://doi.org/10.1016/j.vaccine.2014.08.040

Andrews, M. (2018, March 23). *Adults skipping vaccines may miss out on effective new Shingles shot*. Kaiser Health News. https://khn.org/news/adults-skipping-vaccines-may-miss-out-on-effective-new-shingles-shot/

Australian Institute of Health and Welfare. (2018). *Tetanus in Australia*. https://www.aihw.gov.au/getmedia/f877a2da-23e3-4516-948f-df05ca7ceb43/aihw-phe-236_Tetanus.pdf.aspx

Centers for Disease Control and Prevention. (2018a). *Tetanus*. https://www.cdc.gov/vaccines/pubs/pinkbook/downloads/tetanus.pdf

Centers for Disease Control and Prevention. (2018b). *Tetanus: Questions and Answers*. https://www.immunize.org/catg.d/p4220.pdf

Chan, S. S. C., Leung, D. Y. P., Leung, A. Y. M., Lam, C., Hung, I., Chu, D., Chan, C. K., Johnston, J., Liu, S. H., Liang, R., Lam, T. H., & Yuen, K. Y. (2015). A nurse-delivered brief health education intervention to improve pneumococcal vaccination rate among older patients with chronic diseases: A cluster randomized controlled trial. *International Journal of Nursing Studies*, *52*(1), 317–324. https://doi.org/10.1016/j.ijnurstu.2014.06.008

Chapman, R. S., Cross, K. W., & Fleming, D. M. (2003). The incidence of shingles and its implications for vaccination policy. *Vaccine*, *21*(19–20), 2541–2547. https://doi.org/10.1016/s0264-410x(03)00034-3

Disease data for tetanus from ECDC Surveillance Atlas. (2019). European Centre for Disease Prevention and Control. https://www.ecdc.europa.eu/en/tetanus/surveillance-and-disease-data/atlas

Eilers, R., Krabbe, P. F. M., & de Melker, H. E. (2014). Factors affecting the uptake of vaccination by the elderly in Western society. *Preventive Medicine*, *69*, 224–234. https://doi.org/10.1016/j.ypmed.2014.10.017

Evans, D. L. (2010, February 1). *Importance of vaccination against herpes zoster | The Journal of the American Osteopathic Association*. Journal of Osteopathic Medicine. https://jaoa.org/article.aspx?articleid=2093897

Faulkner, A. E., & Tiwari, T. S. P. (2017). *Surveillance Manual Tetanus Vaccine Preventable Diseases CDC*. Centers for Disease Control and Prevention. https://www.cdc.gov/vaccines/pubs/surv-manual/chpt16-tetanus.html

Gabutti, G., Valente, N., Sulcaj, N., & Stefanati, A. (2014). Evaluation of efficacy and effectiveness of live attenuated Zoster Vaccine. *Journal of Preventive Medicine and Hygiene*, *55*(4), 130–136. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4718315/pdf/1121-2233-55-130.pdf

Georgakopoulou, T., Horefti, E., Vernardaki, A., Pogka, V., Gkolfinopoulou, K., Triantafyllou, E., Tsiodras, S., Theodoridou, M., Mentis, A., & Panagiotopoulos, T. (2018). Ongoing measles outbreak in Greece related to the recent European-wide epidemic. *Epidemiology and Infection*, *146*(13), 1692–1698. https://doi.org/10.1017/s0950268818002170

Groves, N. (2014, September 1). *Low use of herpes zoster vaccine raises concerns*. Ophthalmology Times. https://www.ophthalmologytimes.com/view/low-use-herpes-zoster-vaccine-raises-concerns

Hales, C. M., Harpaz, R., Joesoef, M. R., & Bialek, S. R. (2013). Examination of links between Herpes Zoster incidence and childhood Varicella vaccination. *Annals of Internal Medicine*, *159*(11), 739. https://doi.org/10.7326/0003-4819-159-11-201312030-00006

Harvey, M., Prosser, L. A., Rose, A. M., Ortega-Sanchez, I. R., & Harpaz, R. (2019). Aggregate health and economic burden of herpes zoster in the United States: illustrative example of a pain condition. *Pain*, *161*(2), 361–368. https://doi.org/10.1097/j.pain.0000000000001718

Health Navigator New Zealand. (2020, June 16). *Tetanus | Health Navigator NZ*. https://www.healthnavigator.org.nz/health-a-z/t/tetanus/#:%7E:text=In%20New%20Zealand%2C%20tetanus%20is,four%20and%2011%20years%20old.

Hibberd, P. L., Weller, P. F., & Mitty, J. (2018). *Tetanus-diphtheria toxoid vaccination in adults*. Up To Date. https://www.uptodate.com/contents/tetanus-diphtheria-toxoid-vaccination-in-adults?search=tetanus-diptheria%20toxoid%20vaccination%20in%20adullts&source=search_result&selectedTitle=1~135&usage_type=default&display_rank=1

Hoshi, S.-, Kondo, M., & Okubo, I. (2017). Cost-effectiveness of varicella vaccine against herpes zoster and post-herpetic neuralgia for elderly in Japan. *Vaccine*, *35*(24), 3264–3271. https://doi.org/10.1016/j.vaccine.2017.04.046

Hurley, L. P., Harpaz, R., Daley, M. F., Crane, L. A., Beaty, B. L., Barrow, J., Babbel, C., Marin, M., Steiner, J. F., Davidson, A., Dickinson, L. M., & Kempe, A. (2008). National Survey of Primary Care Physicians Regarding Herpes Zoster and the Herpes Zoster Vaccine. *The Journal of Infectious Diseases*, *197*(s2), S216–S223. https://doi.org/10.1086/522153

Hussain, A., Ali, S., Ahmed, M., & Hussain, S. (2018). The Anti-vaccination Movement: A Regression in Modern Medicine. *Cureus*, 8. https://doi.org/10.7759/cureus.2919

Johnson, D. R., Nichol, K. L., & Lipczynski, K. (2008). Barriers to Adult Immunization. *The American Journal of Medicine*, *121*(7), S28–S35. https://doi.org/10.1016/j.amjmed.2008.05.005

Jones, L. G., Zhang, Y., Ahmed, M. I., Ekundayo, O. J., Akhter, S., Sawyer, P., Aban, I., Sims, R. V., & Ahmed, A. (2010). Understanding the Reasons for the Underuse of Pneumococcal Vaccination by Community-Dwelling Older African Americans. *Journal of the American Geriatrics Society*, *58*(12), 2323–2328. https://doi.org/10.1111/j.1532-5415.2010.03181.x

Jumaan, A. O., Yu, O., Jackson, L. A., Bohlke, K., Galil, K., & Seward, J. F. (2005). Incidence of Herpes Zoster, Before and After Varicella-Vaccination–Associated Decreases in the Incidence of Varicella, 1992–2002. *The Journal of Infectious Diseases*, *191*(12), 2002–2007. https://doi.org/10.1086/430325

Kawai, K., Yawn, B. P., Wollan, P., & Harpaz, R. (2016). Increasing Incidence of Herpes Zoster Over a 60-year Period From a Population-based Study. *Clinical Infectious Diseases*, *63*(2), 221–226. https://doi.org/10.1093/cid/ciw296

Kwon, D. S., Kim, K., & Park, S. M. (2016). Factors associated with influenza vaccination coverage among the elderly in South Korea: the Fourth Korean National Health and Nutrition Examination Survey (KNHANES IV). *BMJ Open*, *6*(12), e012618. https://doi.org/10.1136/bmjopen-2016-012618

Mahamud, A., Marin, M., Nickell, S. P., Shoemaker, T., Zhang, J. X., & Bialek, S. R. (2012). Herpes Zoster-Related Deaths in the United States: Validity of Death Certificates and Mortality Rates, 1979–2007. *Clinical Infectious Diseases*, *55*(7), 960–966. https://doi.org/10.1093/cid/cis575

Martins, D., McCormack, D., Tadrous, M., Gomes, T., Kwong, J. C., Mamdani, M. M., Buchan, S. A., & Antoniou, T. (2020). Impact of a Publicly Funded Herpes Zoster Immunization Program on the Burden of Disease in Ontario, Canada: A Population-based Study. *Clinical Infectious Diseases*, *72*(2), 279–284. https://doi.org/10.1093/cid/ciaa014

Mirinaviciute, G., Quist-Paulsen, E., Brantsæter, A. B., & Flem, E. (2020). The burden of herpes zoster disease in Norway. *Vaccine*, *38*(18), 3501–3507. https://doi.org/10.1016/j.vaccine.2019.11.054

Nakayama, T. (2013). Vaccine chronicle in Japan. *Journal of Infection and Chemotherapy*, *19*(5), 787–798. https://doi.org/10.1007/s10156-013-0641-6

Otsuka, S. H., Tayal, N. H., Porter, K., Embi, P. J., & Beatty, S. J. (2013). Improving Herpes Zoster Vaccination Rates Through Use of a Clinical Pharmacist and a Personal Health Record. *The American Journal of Medicine*, *126*(9), 832.e1-832.e6. https://doi.org/10.1016/j.amjmed.2013.02.018

Our Best Shot: Expanding Prevention through Vaccination in Older Adults. (2015, July 28). Alliance for Aging Research. https://www.agingresearch.org/document/our-best-shot-expanding-prevention-through-vaccination-in-older-adults/

Piltch-Loeb, R., & DiClemente, R. (2020). The Vaccine Uptake Continuum: Applying Social Science Theory to Shift Vaccine Hesitancy. *Vaccines*, *8*(1), 76. https://doi.org/10.3390/vaccines8010076

Pinchinat, S., Cebrián-Cuenca, A. M., Bricout, H., & Johnson, R. W. (2013). Similar herpes zoster incidence across Europe: results from a systematic literature review. *BMC Infectious Diseases*, *13*(1), 1. https://doi.org/10.1186/1471-2334-13-170

Potts, A., Williams, G. J., Olson, J. A., Pollock, K. G. J., Murdoch, H., & Cameron, J. C. (2014). Herpes zoster ophthalmicus reduction: implementation of shingles vaccination in the UK. *Eye*, *28*(3), 247–248. https://doi.org/10.1038/eye.2013.303

Products - Data Briefs - Number 281 - June 2017. (2017). Centers for Disease Control and Prevention. https://www.cdc.gov/nchs/products/databriefs/db281.htm

Public Health Agency of Canada. (2019). *Vaccination for adults - Canada.ca*. Government of Canada. https://www.canada.ca/en/public-health/services/vaccination-adults.html

Quan, D., Cohrs, R. J., Mahalingam, R., & Gilden, D. H. (2007). Prevention of Shingles: Safety and Efficacy of Live Zoster Vaccine. *Therapeutics and Clinical Risk Management*, *3*(4), 633–639. https://www.researchgate.net/publication/5378642_Prevention_of_shingles_Safety_and_efficacy_of_live_zoster_vaccine

Schmader, K. E., Oxman, M. N., Levin, M. J., Johnson, G., Zhang, J. H., Betts, R., Morrison, V. A., Gelb, L., Guatelli, J. C., Harbecke, R., Pachucki, C., Keay, S., Menzies, B., Griffin, M. R., Kauffman, C., Marques, A., Toney, J., Keller, P. M., Li, X., … Annunziato, P. (2012). Persistence of the Efficacy of Zoster Vaccine in the Shingles Prevention Study and the Short-Term Persistence Substudy. *Clinical Infectious Diseases*, *55*(10), 1320–1328. https://doi.org/10.1093/cid/cis638

Shimazawa, R., & Ikeda, M. (2012). The vaccine gap between Japan and the UK. *Health Policy*, *107*(2–3), 312–317. https://doi.org/10.1016/j.healthpol.2012.05.012

Shingles Clinical Overview - Varicella Vaccine. (2018). Centers for Disease Control and Prevention. https://www.cdc.gov/shingles/hcp/clinical-overview.html

Shingles Surveillance, Trends, Deaths. (2018). Centers for Disease Control and Prevention. https://www.cdc.gov/shingles/surveillance.html

Shingrix Shingles Vaccination: What Everyone Should Know. (2019). Centers for Disease Control and Prevention. https://www.cdc.gov/vaccines/vpd/shingles/public/shingrix/

Streeter, S. B., Schwartzberg, L., Husain, N., & Johnsrud, M. (2011). Patient and Plan Characteristics Affecting Abandonment of Oral Oncolytic Prescriptions. *Journal of Oncology Practice*, *7*(3S), 46s–51s. https://doi.org/10.1200/jop.2011.000316

Tabbarah, M., Zimmerman, R. K., Nowalk, M. P., Janosky, J. E., Troy, J. A., Raymund, M., & Jewell, I. K. (2005). What Predicts Influenza Vaccination Status in Older Americans over Several Years? *Journal of the American Geriatrics Society*, *53*(8), 1354–1359. https://doi.org/10.1111/j.1532-5415.2005.53424.x

Teeter, B. S., Garza, K. B., Stevenson, T. L., Williamson, M. A., Zeek, M. L., & Westrick, S. C. (2014). Factors associated with herpes zoster vaccination status and acceptance of vaccine recommendation in community pharmacies. *Vaccine*, *32*(43), 5749–5754. https://doi.org/10.1016/j.vaccine.2014.08.040

Telford, R. (2003). What influences elderly peoples' decisions about whether to accept the influenza vaccination? A qualitative study. *Health Education Research*, *18*(6), 743–753. https://doi.org/10.1093/her/cyf059

Tetanus. (2020, March 13). The Australian Immunisation Handbook. https://immunisationhandbook.health.gov.au/vaccine-preventable-diseases/tetanus#:%7E:text=Tetanus%2Dcontaining%20vaccines%20are%20only,11%E2%80%9313%20years%20of%20age.

Tetanus Clinical Information: Lockjaw. (2016). Centers for Disease Control and Prevention. https://www.cdc.gov/tetanus/clinicians.html

Tetanus Disease: Lockjaw. (2018). Centers for Disease Control and Prevention. https://www.cdc.gov/tetanus/index.html

The United States Government Accountability Office. (2011, December). *Medicare: Many factors, including administrative challenges, affect access to Part D vaccinations*. https://www.gao.gov/assets/gao-12-61.pdf

Thomas, R. E., & Lorenzetti, D. L. (2018). *Interventions to increase Influenza vaccination rates of those 60 years and older in the community*. Cochrane Collaboration. https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD005188.pub4/epdf/abstract

VFC Publication on Cost-Benefits Vaccines CDC. (2014). Centers for Disease Control and Prevention. https://www.cdc.gov/vaccines/programs/vfc/pubs/methods/index.html

Weinberger, B. (2018). Vaccines for the elderly: current use and future challenges. *Immunity & Ageing*, *15*(1), 3. https://doi.org/10.1186/s12979-017-0107-2

Whitney, C. G., Zhou, F., Singleton, J., & Schuchat, A. (2014, April 25). *Benefits from Immunization During the Vaccines for Children Program Era — United States, 1994–2013*. Centers for Disease Control and Prevention. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6316a4.htm

World Health Organization. (2018, August 20). *Measles cases hit record high in the European Region*. https://www.euro.who.int/en/media-centre/sections/press-releases/2018/measles-cases-hit-record-high-in-the-european-region

Zimmerman, R. K., Santibanez, T. A., Janosky, J. E., Fine, M. J., Raymund, M., Wilson, S. A., Bardella, I. J., Medsger, A. R., & Nowalk, M. P. (2003). What affects influenza vaccination rates among older patients? An analysis from inner-city, suburban, rural, and veterans affairs practices. *The American Journal of Medicine*, *114*(1), 31–38. https://doi.org/10.1016/s0002-9343(02)01421-3

BIOGRAPHICAL SKETCH

Ogulsoltan Arazgeldiyeva was born in Ashgabat, Turkmenistan. She has graduated Ashgabat Turkish Anatolian High School as a valedictorian in 2004. After high school graduation, Ogulsoltan moved to the United States to continue her education. She earned her Bachelor of Arts in Economics with cum laude Latin honors from The University of Texas at Dallas in 2010. In 2012, she started her Public Policy and Political Economy doctoral program at The University of Texas at Dallas. Due to her health field interest, she focused to specialize in health policy research. Ogulsoltan is interested in factors affecting senior vaccination rate in the United States, factors affecting children mortality rate in Central Asia, and long term effects of COVID-19 health crisis.

CURRICULUM VITAE

OGULSOLTAN ARAZGELDIYEVA

EDUCATION

PHD | MAY 2021 (EXPECTED) | UNIVERSITY OF TEXAS AT DALLAS
· Major: Public Policy and Political Economy
· Field: Health Policy Research
· Dissertation: Factors affecting the Shingles vaccination rate in seniors: The Shingles (Zostavax) and Tetanus vaccination comparison.
· Statistical Programs: STATA, R, MPlus, ArcGIS

BACHELOR OF ARTS | MAY 2010 | UNIVERSITY OF TEXAS AT DALLAS
· Major: Economics
· Cum Laude Latin Honors

PROFESSIONAL EXPERIENCE

MATH TEACHER | HARMONY PUBLIC SCHOOLS | JULY 2010-JULY 211
· Full time 4th and 5th grade Math teacher
· Math League and Math Counts Club Leader

PRIVATE MATH TUTOR | JULY 2010 – DECEMBER 2015
· Tutored Middle and High School students in Algebra, Geometry, Calculus.

TURKMEN AMERICAN SCHOLARS ASSOCIATON | JULY 2007 – PRESENT
· Co-founder and active member organizing symposiums annually.

MANUSCRIPTS IN PREPARATION
Factors affecting the Shingles vaccination rate in seniors: The Shingles (Zostavax) and Tetanus vaccination comparison.

AWARDS AND RECOGNITIONS
· Turkish Student Association Scholarship UT Dallas 2015-2018
· Cum Laude Latin Honors UT Dallas 2010
· Tau Sigma Transfer Honor Society 2008
· Academic Excellence Scholarship, UT Dallas 2008-2010
· Milwee Dedman College Scholar, Southern Methodist University 2008

LANGUAGES

Turkmen (Native); Russian (Fluent); Turkish (Fluent); English (Fluent).