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The Impact of Vaccine Coverage and Exemptions on the Resurgence of Vaccine Preventable

Diseases: A Review of the Literature

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Abstract

Vaccinations are a safe and effective way to prevent the spread of disease. In recent years, vaccine coverage rates have declined while nonmedical exemption rates have increased. These changes have contributed to increased prevalence of vaccine preventable diseases. Declining vaccine coverage and increasing nonmedical exemptions are a threat to public health and the relationship between these factors needs to be understood. Clusters and outbreaks of vaccine preventable diseases have occurred as a result of more people declining vaccination. Factors that may incline someone to refuse vaccination include safety concerns, lack of trust, freedom of choice, decreased understanding for the need, technology, and accessibility. The ease of obtaining a nonmedical exemption is associated with the increase in nonmedical exemptions and decrease in coverage. States with more stringent exemptions policies have lower rates of exemptions and states that do not accept nonmedical exemptions have increased vaccine uptake. Recommendations to improve vaccine coverage include changes to areas such as education, accessibility, finances, and laws and policies.

Keywords: nonmedical exemptions, vaccine coverage, vaccine preventable diseases

The Impact of Vaccine Coverage and Exemptions on the Resurgence of Vaccine Preventable Diseases: A Review of the Literature

Vaccines are one of the most effective methods to prevent diseases such as measles, mumps, varicella, and pertussis. Although there is sufficient scientific evidence to prove that vaccinations are safe and effective in preventing diseases, some people choose to not immunize themselves or their children. The anti-vaccine movement regained popularity in 1998 after Andrew Wakefield published a study that linked the measles, mumps, and rubella (MMR) vaccine to autism (Wakefield et al., 1998). Although there have been several studies that have proven there is no association between the MMR vaccine and autism, parents still have safety concerns regarding vaccines which is one of the reasons vaccines have been highly scrutinized (Omer et al., 2009). Due to several concerns about vaccines, the number of children without vaccines is increasing which has resulted in outbreaks of vaccine preventable diseases (Centers for Disease Control and Prevention [CDC], 2018).

In an attempt to keep vaccine preventable diseases under control and achieve high immunization rates, the United States of America made it mandatory for children to be vaccinated before entering school (CDC, 2016). While this law was established to protect the population against potentially fatal diseases and maintain high immunization rates, it has not been entirely successful due to the availability of exemptions from vaccines. There are two types of vaccination exemptions: medical exemptions and nonmedical exemptions. Medical exemptions are given when an individual cannot receive a vaccine because they are immunocompromised or have an allergy to an ingredient in the vaccine. Nonmedical exemptions include religious and philosophical exemptions and the laws regarding availability and ease of obtaining these exemptions depends on state laws (Malone & Hinman, 2003).

Nonmedical exemption rates have increased in recent years which has had a devastating effect on vaccination coverage rates and prevalence of vaccine preventable diseases. The most notable problem with a rise in exemption is that the rate of vaccine coverage decreases which puts people at risk for contracting a potentially fatal and preventable disease. In 2019, there were 1,282 cases of measles which was the highest number reported since 1992 and the majority of those with the disease were not vaccinated (CDC, 2020). When an outbreak of vaccine preventable diseases occurs, it is associated with an increase in healthcare related costs. In a 2008 measles outbreak in San Diego, total costs were valued at about \$10,376 per case and the impact of measles cases in 2008 in two hospitals was about \$799,136 (Constable, Blank, & Caplan, 2014).

Nonmedical exemptions pose a threat to the health of the population which needs to be further investigated. This review will focus on vaccination coverage, vaccination hesitancy, exemption rates and policies. Recommendations will be made regarding practices that may improve vaccination coverage.

Vaccination Coverage

Vaccinations are crucial to the health of the population and currently prevent two to three million deaths per year according to the World Health Organization (2019). Successful vaccination programs are responsible for the eradication of polio and smallpox in the United States and for the elimination of measles in 2000 (CDC, 2018a, 2019). Unfortunately, the occurrence of diseases such as measles, chicken pox, and pertussis are increasing because immunization rates are decreasing. In recent years, a number of parents have declined vaccinations which increases the number of children that are not protected against vaccine preventable diseases. In 2016, the percentage of unvaccinated children was 0.8% rising to 1.1%

in 2017 (CDC, 2018c). The percentage of children with no vaccinations by age two was 0.9% for children born in 2011 and increased to 1.3% for children born in 2015. The increase in number of children with no vaccines by age two is alarming, especially since young children are at risk for contracting diseases.

The United States has seen an increase in measles cases in recent years. In 2016, there were 86 measles cases reported and in 2019 there were 1,282 cases reported (CDC, 2020). The drastic increase in measles outbreaks can be related to vaccine coverage rates in the United States. The national MMR vaccine coverage rate for children enrolled in kindergarten for the 2017-2018 school year was 95% with a range from 88.7% in Colorado to 99.4% in Mississippi (CDC, 2018b). During the 2018-2019 school year, the number of kindergartners that received MMR vaccinations decreased to 94.7%. The CDC also tracks vaccination rates for adolescents ages 13-17. In 2017, 92.1% of adolescents were vaccinated against the measles with a decrease to 91.9% in 2018 (CDC, 2019b). The percentage of adolescents vaccinated raises concern because it is below the herd immunity threshold for the measles. Although the changes in vaccine coverage between these two groups is small between each year, it shows a decrease in immunization rates that puts the public at risk for the spread of measles because the number of people immune to the disease is not high enough.

The effectiveness of vaccines lies in the numbers of individuals that are immunized. When an individual gets vaccinated, they are protected against the disease. Since they are protected and cannot get the disease, it also prevents them from spreading the disease and making others sick. This concept is called herd immunity (Vaccines Protect Your Community, 2020). Herd immunity is critical because it provides protection for people who cannot receive vaccines such as newborn babies and immunocompromised individuals, as well as people who

have weaker immune systems such as the elderly. Herd immunity is only effective if a large portion of the population is immunized (Rogers, 2018). The percentage of individuals vaccinated to ensure herd immunity can range from 35% to 95% based on the contagiousness of the disease.

Measles requires one of the highest percentages of individuals to be vaccinated for herd immunity to be effective with a threshold of 93%-95% (Oehler, 2020). This is problematic since vaccine coverage varies not only by state but by cities within a state as well. In many areas, the percentage of individuals that are immunized for measles falls below 93%. For the 2018-2019 school year, there were 14 states with MMR coverage rates below 93% for kindergartners (CDC, 2019b). The states include: Colorado, Idaho, Alabama, Washington, Kansas, Indiana, Hawaii, Ohio, New Hampshire, Oklahoma, Minnesota, Wisconsin, Utah, and Arizona. Colorado's rate was the lowest in the United States with 87.4% being vaccinated which is significantly below the threshold; Mississippi had the highest MMR coverage with 99.4% of kindergartners being vaccinated. In Michigan, Oscoda County's immunization rate is 76.1% which is 20.6% lower than Ontonagon County which has the highest immunization rate in Michigan (Michigan Department of Health and Human Services, 2019). Although Michigan does not report vaccination coverage by the MMR vaccine rate alone, it indicates that coverage rates can vary depending on location within a state which poses a threat to herd immunity.

If one area or community has a significantly low vaccination rate, it creates a pocket of unvaccinated individuals which increases the risk of the spread of vaccine preventable diseases (Rogers, 2018). The pockets of unvaccinated individuals are often referred to as clusters and increase susceptibility to infection which can lead to outbreaks of diseases (Whittington et al, 2017). Clustering occurs because individuals who share similar beliefs about vaccines often live in close proximity to one another (May & Silverman, 2003). If enough people who oppose

vaccines live in a specific area, it is likely that the number of those who are not vaccinated will reach a critical number and herd immunity will no longer be effective which makes it easier for vaccine preventable diseases to spread. In a study performed by Whittington et al. (2017), findings exhibited that regions with decreased vaccine coverage (below herd immunity threshold) and easy exemption policies are two times more likely to experience an outbreak when compared to an area meeting the national vaccine coverage rate. In another study performed by Wang et al. (2014), the authors found that the risk for unvaccinated individuals is 22-35 times greater for contracting measles and 6 times greater for the contraction of pertussis. The findings illustrate the importance of maintaining high vaccination rates to prevent clusters and outbreaks.

Clustering has been associated with both pertussis and measles outbreaks throughout history. In 2019, 934 cases of measles were associated with an Orthodox Jewish community that was close-knit (CDC, 2019c). A cluster of intentionally unvaccinated children in San Diego private and public charter schools was responsible for a measles outbreak in 2008 (Constable et al., 2014). In August of 2019 in Rockland County, NY there were 290 confirmed cases of measles and 78.3% of those infected were not vaccinated with the MMR vaccine (Hecht & Haney, 2019). In 2008, a cluster of vaccine exemptions in Michigan caused critically low vaccination coverage rate which lead to a pertussis outbreak (Omer et al., 2008). In 2004-2005 in Delaware and 2009-2010 in Illinois, Amish communities who had not vaccinated due to cultural norms experienced pertussis outbreaks (Phadke et al, 2016). These examples of outbreaks demonstrate that when individuals who share common beliefs live nearby, it provides the opportunity for outbreaks.

Other important outbreaks that are worth noting include the measles outbreaks between 2018 and 2019, the California Disney outbreak in 2015, and the California pertussis outbreak in 2010. Between January 1, 2019 and October 1, 2019, there were 1,249 cases of measles in the United States and 89% of individuals affected were unvaccinated (CDC, 2019c). There were 22 outbreaks in 17 states; of those outbreaks, there were eight outbreaks that were in an area of decreased vaccination coverage within a close community which accounted for 85% of the cases. In December of 2014, an unvaccinated 11-year old girl visited a Disney park and was later hospitalized with the measles (Phadke et al., 2016). By February of 2015, there were 125 cases reported in seven states and two other countries that affected individuals who visited the Disney park in late December. Half of the 110 individuals affected in California were willingly unvaccinated. In 2010, a pertussis outbreak in California among children ages 6 months to 18 years who had an available vaccination history revealed that 45% of those affected did not receive the age appropriate vaccines or were under-immunized. Each of these outbreaks affected a substantial number of individuals that were not immunized which presents the importance of vaccination.

Vaccine Hesitancy and the Anti-Vaccine Movement

Although vaccines have been around for many years and protect against potentially fatal vaccine preventable disease, many individuals still decide to delay or refuse immunizations for themselves or their children. There has been a shift that has caused many people to be more worried about the harm that vaccines can cause compared to harm caused by a vaccine preventable disease. The public has been weary of vaccines since they were first created. When the smallpox vaccine was first created it was met with concerns such as the right of man to interfere with diseases, injecting foreign materials into the body, and the infringement of freedom

(Siddiqui, Salmon, & Omer, 2013). The recent decline in immunization rates can be attributed to the anti-vaccine movement and vaccine hesitancy. Reasons for vaccine hesitancy and the anti-vaccine movement are multifactorial.

Safety

Vaccine safety was found to be the primary reason that parents refused to vaccinate their children in measles outbreaks in Indiana (Omer et al., 2006). Unfortunately, this is not uncommon as vaccine safety is often one of the most popular reasons individuals refuse vaccinations. Many people believe that the harm vaccines may cause do not outweigh the benefits of them (Hussain et al., 2018). In a study performed by Kennedy and Gust (2008), vaccine safety concerns included harm due to adverse reactions or autism, chemicals in the vaccines, contracting the disease from the vaccine, and receiving too many shots at one time. Lee et al. (2016) also found that the number of vaccines children receive are a factor relating to why parents decline vaccination. Parents worry that the number of shots given at one time overloads the immune system and harms the child. According to a case control study performed by Salmon et al. (2005), 49% of people believed that the number of vaccines overload the immune system and 69% believe that vaccines cause harm.

Lack of Trust

Lack of trust is another factor in vaccine hesitancy (Constable et al., 2014; Gaudino & Robinson, 2012; Lee et al., 2016; Rogers, 2018; Salmon et al., 2005; Siddiqui et al., 2013; Wang et al., 2014). Distrust in governmental and pharmaceutical companies are frequently cited reasons for lack of trust (Gaudino & Robinson, 2012; Jolley & Douglas, 2014; Salmon et al., 2005; Siddiqui et al., 2013). In a study performed by Lee et al. (2016), those that distrust the government were likely to classify government sources (CDC and local and state health

departments) as non-reliable sources of information while vaccine information from alternative medicine providers was classified as reliable or very good. The most common reason for lack of trust in pharmaceutical companies is related to profits (Jolley & Douglas, 2014; Glatman-Freedman & Nichols, 2012). Vaccine hesitant individuals believe that pharmaceutical companies care more about making money so they bribe researchers to alter data and hide harmful side effects. There was also found to be a lack of trust in medical providers regarding vaccines (Lee et al., 2016; Rogers, 2018; Wang et al., 2014; Siddiqui et al., 2013). Part of the reason parents do not trust doctors is because of the lack of time doctors spend with parents (Siddiqui et al., 2013). The short appointment times do not allow for doctors and parents to have a conversation about vaccines so they find information from other sources. According to Lee et al. (2016), parents who lack trust in medical providers are 1.77 times more likely than trusting parents to seek information from other sources such as parent organizations that are against vaccines. Decreased trust in medical providers, the government, and pharmaceutical companies leads to decreased trust in information materials from these sources (Gaudino & Robinson, 2012; Wang et al., 2014). When individuals do not trust the research conducted by government and medical providers, they seek their own information and form their own opinions which may be based on sources that are not credible. Further direction is needed to discover and implement programs that would increase trust in these entities to improve vaccination rates.

Freedom of Choice

The United States has made it mandatory for children to be vaccinated before they attend school to increase vaccine uptake. However, many parents believe that mandatory vaccination removes their freedom to choose which inclines them not to vaccinate (Rogers, 2018). Parents also feel pressure to vaccinate from the pediatrician. However, parents in recent years have

expressed that they no longer want to be told what to do for their child by the doctor (Siddiqui et al., 2013). Parents want to feel like a partner in the decision making process which is difficult because of the short amount of time doctors are allotted to spend with their patients. Parents also feel like they do not know enough about vaccines to make an informed decision because of the immunization requirement law (Lee et al., 2016).

Need for Vaccination

Reluctance to vaccinate also stems from the decreased understanding regarding the need for vaccines (Rogers, 2018). In a case control study performed by Salmon et al. (2005), parents did not vaccinate because the perceived susceptibility to the disease is low. There is also a lack of appreciation for the severity of the disease (Rota et al., 2001). The lack of appreciation is because vaccine preventable diseases are generally low in prevalence. This can lead to a decrease in vaccine rates because the diseases are not perceived as a threat (Constable et al., 2014).

Technology

Part of the reason that the anti-vaccine movement and vaccine hesitancy has become more common in recent years is because of technology. Technologies such as the internet have made it very easy for false information about vaccines to reach more people and it plays a large role in the decision to not vaccinate. The internet has made it easier for the anti-vaccine movement to gain followers due to the increased number of people they are able to reach. Individuals are able to research various topics on their own from many different sources that are not evidenced based. Researchers found that 32% of YouTube videos advocated against vaccination and that those videos had more views than videos that promoted vaccination (Hussain et al., 2018). A study found that 43% of websites that populated on google after searching “vaccination” and “immunization” promoted the anti-vaccine movement (Davies,

Chapman, & Leask, 2002). Kortum, Edwards, and Richards-Kortum (2008) examined how people evaluated the accuracy of vaccine information from 40 websites. Out of the 40 websites, 22 of them had inaccurate information that was not evidence based but each participant believed the site they found displayed accurate information. After the participants were exposed to this information, 53% of them had misconceptions about vaccines because of the information they were exposed to. The abundance of inaccurate information about vaccines on the internet makes it difficult for those trying to learn more about vaccines to make decisions based on scientific evidence.

Access and Convenience

Access to vaccines and convenience also play a role in whether or not someone decides to receive vaccinations. A study performed found that parents who did not necessarily oppose vaccination filed for vaccine exemptions due to lack of immediate access to vaccination records (Luthy et al., 2012). Some families may also have limited accessibility to healthcare facilities where they would have to go to receive vaccines (Glatman-Freedman & Nichols, 2012). Access can be effected by level of transportation as well as knowledge; some may not know where to go or how to go about receiving services that would assist them in obtaining vaccinations.

Exemption Rates and Policies

Each state requires by law that all children entering schools and day care facilities be vaccinated, however, parents are able to obtain an exemption from vaccination for various reasons in each state (CDC, 2016). There are two main types of vaccine exemptions: medical and nonmedical exemptions (Malone & Hinman, 2003). Medical exemptions are allowed in all 50 states and a physician is required to sign a form for it to be accepted. A physician may grant a

medical exemption if an individual has a condition that may increase the risk of an adverse effect from the vaccine or if they are unable to receive a vaccine for any other medical reason.

There are two types of nonmedical exemptions: religious and philosophical (Malone & Hinman, 2003). Religious exemptions are used when vaccination goes against a person's sincere religious beliefs and philosophical exemptions are used when vaccines go against morals or other personal beliefs (NCSL, 2020). Each state has their own laws regarding which nonmedical exemptions they accept. There are 45 states that allow religious exemptions and 15 that allow philosophical exemptions. California, New York, Maine, West Virginia, and Mississippi do not accept nonmedical exemptions. California enacted this law in 2015 after a measles outbreak that began in Disneyland spread to several people who had not been immunized due to personal beliefs (Hussain et al., 2018). Nonmedical exemptions are extremely controversial due to the threat they pose to vaccination coverage and herd immunity.

The nonmedical exemption rate for 2018-2019 was 2.5% which increased from 2% in 2016-2017 (Seither et al., 2019). For the 2018-2019 school year, 2.2% of kindergartners had nonmedical exemptions. While this may seem like a small percentage, there are states and counties with rates much higher than the national average which increases the risk of an outbreak. During the 2011-2012 school year, Washington state reported a nonmedical exemption rate of 4.2%, but county rates were as high as 26.2% (Siddiqui et al., 2013). In a study performed by Olive, Hotez, Damania, and Nolan (2018), nonmedical exemptions trends in 18 states were analyzed and several hotspots in the United States were identified. Counties where more than 400 kindergartners received nonmedical exemptions for the 2016-2017 school year include counties in states such as Washington, Oregon, Utah, Arizona, Texas, Missouri, Pennsylvania, and Michigan. Findings from the same study exhibited that states that do not accept nonmedical

exemptions have the highest rates of MMR vaccine uptake which means they are less at risk for vaccine preventable diseases. In states that allow philosophical and religious exemptions, the exemption rate was 2.41 times as high compared to states that only allow religious exemptions (Omer et al., 2017).

Each state has control over the process in place for obtaining nonmedical exemptions (CDC, 2016). The processes can vary greatly by state. The form needed for the exemptions can be obtained through the school, online, or from the health department (Omer et al., 2017). Other states may require a letter from a parent or guardian that may or may not need to be notarized, a letter from the health department, signatures from religious leaders or state officials, or counseling with a health professional about vaccines. Depending on the steps needed to obtain an exemption, it can be easier in some states than others to get an exemption. In a study performed by Omer et al. (2017), the authors evaluated the association between the ease of obtaining nonmedical exemptions and exemption rates. The authors classified exemptions processes as easy, medium, and difficult. In easy policy states, a form with a parent signature is required and the form is available online or at school. In medium policy states the items required include a form with a parent signature. The form is available from the health department and requires a personal statement from parent, and a visit to the health department. In difficult states, the requirements are the same as medium policies except for the addition of a signature from a religious or state official, yearly recertification, and the form must be notarized. There were 8 states with an easy exemption policy, 18 states with a medium policy, and 23 states with difficult exemption processes. The states with easy exemption policies had a nonmedical exemption rate of 2.97% compared to a rate of 1.84% in states with difficult exemption policies. This data

exhibits that lenient nonmedical exemption policies increase the rate of exemptions and decrease immunization rates which leaves communities vulnerable to vaccine preventable diseases.

Recommendations

Declining vaccination rates and the resurgence of vaccine preventable diseases have brought attention to the need for recommendations in an effort to increase vaccination rates. Increased vaccine coverage is essential to protect individuals who cannot be immunized because they are too young or have certain medical conditions as well as those who are immunized but do not have an effective reaction to the vaccine (CDC, 2018). It is important for recommendations to encompass many different areas for improvement because there are several reasons for low vaccination rates. Areas included in recommendations to increase vaccination include laws and policies, accessibility, education, and finances.

Laws and Policies

Recommendations directed toward changing laws and policies include nonmedical exemptions and school policies in place when children are unvaccinated or under-vaccinated. Recommendations regarding nonmedical exemptions include eliminating nonmedical exemptions or making it more difficult to obtain nonmedical exemptions (CDC, 2016; Omer et al., 2017). California eliminated nonmedical exemptions in 2015 after a measles outbreak in Disneyland (Hecht & Hayney, 2019). After this law went into effect, the percentage of children behind on immunizations decreased from 7.15% to 4.42%. The decrease in children behind exemplifies how eliminating nonmedical exemptions can improve vaccination rates. Other states including Maine and New York followed suit and eliminated nonmedical exemptions in 2019.

Studies have shown that in states with policies that make it difficult to obtain nonmedical exemptions less people will do so which results in lower exemption rates (Omer et al., 2017;

Rota et al., 2001). Since more stringent exemption policies decrease rates of exemption and increase vaccine uptake, it is likely that this recommendation could be very effective if implemented. Changes that can be made to increase the difficulty of obtaining nonmedical exemptions include requiring parents to visit the local health department to obtain the form and requiring them to have a conversation with medical staff about the benefits of vaccination and the risks of declining vaccination (Constable et al., 2014; Rota et al., 2001). Requiring parents to have counseling with healthcare professionals before obtaining an exemption decreased exemption rates by 40.2% and increased vaccine coverage for children entering school after Washington State passed State Bill 5005 in 2011 (Omer et al., 2018). States that have easy or medium exemption policies according to the criteria used for the study performed by Omer et al. (2017) could also adopt rules such as requiring yearly recertification, notary, and signatures from religious leaders or state officials in an effort to make it more difficult to obtain an exemption.

Changes can also be made regarding school policies when children are behind on vaccinations or are not immunized without a waiver on file. Rota et al. (2001) stated that excluding children from school as a result of noncompliance with vaccine laws has been effective in making sure that parents are staying on track with their child's vaccine schedule. Another way to increase vaccine coverage is to improve the tracking systems that schools use to monitor the students' vaccination record (Mellerson et al., 2018). Kentucky changed the policy so that school nurses are able to use immunization information systems to document vaccine history. This change can help schools stay on top of which students are immunized and which students need to be followed up with if they are missing or behind on vaccinations. Schools can also decrease their provisional enrollment length. Provisional enrollment is when a student is still allowed to attend school even without vaccination or an exemption while they complete a new

vaccination schedule to get them caught up. Pennsylvania decreased their provisional enrollment length from 240 days to 5 days. The modifications to these policies can help increase vaccination coverage for children attending school.

Accessibility

Limited accessibility to vaccination for a variety of reasons affects vaccination coverage (Glatman-Freedman & Nichols, 2012). There are many ways to increase accessibility to vaccines. A study performed by Peterson et al. (2012) implemented school based immunization clinics at the school during and after school hours. The authors found that the school based immunization clinic decreased immunization exemptions and increased the percentage of fully immunized students attending school. Frew and Lutz (2017) recommended outreach programs, transportation programs, and walk-in and after hour immunization clinics. Outreach programs including case management, home visits, and in-home vaccination suggest that children who receive these interventions are 3%-243% more likely to receive immunizations. The programs also improved parental trust in healthcare providers. Increasing public transportation can help improve vaccine coverage because it provides a way for families that do not have access to a car a ride to and from their doctor appointments. Lastly, walk-in and after hour clinics make it easier for parents who work long hours to get their child vaccinated.

Education

Educating parents about vaccines can dispel some of the misinformation they may have been exposed to on the internet or from other sources. When parents are educated, it helps them feel more informed about making the decision to vaccinate and also makes them feel like a partner in the process (Frew & Lutz, 2017). In a randomized control trial (RCT), parental viewing of a video about vaccines and a handout decreased scores by 5.2 points on a parental

attitude about childhood vaccines scale. This decrease in points means that there was a decrease in parental hesitancy because of the education received. It is also important to simplify education material so that it is easy for every person to understand (Constable et al., 2014). Educating parents about vaccines as early as possible beginning during pregnancy is another way to increase vaccination (Frew & Lutz, 2017). A RCT found that 90% of children born to mothers who received prenatal vaccination education were fully immunized at one year-old compared to only 82.9% of children whose mother did not receive prenatal education.

Finances

Constable et al. (2014) recommended several financial related changes that can be made in an effort to increase vaccination coverage. The first recommendation is to offer financial incentives to individuals who immunize. Financial incentives have been supported to increase preventative behaviors like vaccination, however, this may be controversial because it can be seen as coercion. Other recommendations stem from the financial burden of vaccine preventable diseases. For example, it has been proposed that people who file for exemptions should share the financial burden during an outbreak of vaccine preventable diseases. There has also been discussion of imposing a tax on people who choose not to vaccinate. The tax idea came from the increase in federal taxes on cigarettes in 2009. After this increase, there was an 8.3% drop in cigarette consumption. If the tax is significant enough for those who chose to obtain an exemption, there may be a decrease in exemption rates.

Discussion

This review shows that declining vaccination coverage and increasing exemption rates contribute to the increase in cases of vaccine preventable diseases. An increasing number of children have not been vaccinated. Vaccine coverage rates have declined in the last few years

among children ages two and under, kindergartners, and adolescents age 13-17 each year.

Vaccination coverage varies greatly by states and counties within states. This is evidenced by the 12% gap in vaccine coverage between Colorado and Mississippi. The variation in coverage rates may lead to clustering. Clustering renders herd immunity ineffective which increases the likelihood that vaccine preventable diseases will spread. Since 2017, immunization rates have declined and the number of measles cases reported has increased each year, reaching 1,282 in 2019.

Many factors are important in understanding why there is a decrease in vaccine coverage and an increase in nonmedical exemptions. Vaccine hesitancy and the anti-vaccine movement have led to an increase in the number of people that do not vaccinate. Reasons people decide not to vaccinate include vaccine safety concerns and lack of trust in medical providers, the government, and pharmaceutical companies. Freedom of choice, decreased understanding for the need to vaccinate, and accessibility also impact the decision to vaccinate.

Nonmedical exemptions have increased exemption rates which threatens vaccination coverage. The nonmedical exemption rate in 2019 was 2.5% which increased from 2% in 2017. Nonmedical exemption rates and the process for obtaining exemptions vary by state. States that do not accept nonmedical exemptions have increased vaccine uptake; States with policies that make it difficult to obtain an exemption have lower exemption rates compared to states with a more lenient process. Changes to exemption policies can be made in an effort to increase vaccine coverage.

Conclusion

Declining vaccine coverage and increasing exemption rates make the public more susceptible to outbreaks of vaccine preventable diseases. To improve vaccine coverage and decrease nonmedical exemption rates in an effort to protect the population, there are many recommendations for change. Policy changes for nonmedical include making the process to obtain an exemption more difficult by requiring counseling with medical providers at the health department as well as eliminating all nonmedical exemptions. Policy changes that can be made at the school level include allowing school nurses to view immunization information systems or decreasing the length of provisional enrollment. To improve accessibility, school based immunization clinics, outreach programs, walk-in clinics, and increased public transportation have been effective in many studies and should be implemented. Education is another important way to increase vaccine coverage. Education recommendations include educational videos and handouts for parents, simplifying education materials, and educating as early as possible. Changes to insurance premiums and taxes may be successful in improving vaccination coverage as well. More research is needed to find effective ways to decrease vaccine hesitancy, decrease exemption rates, and improve vaccination coverage. Future actions and research should focus on implementing and evaluating changes made in an effort to improve vaccination coverage.

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