



The Positive Correlation between Vaccine Refusals and Outbreaks of Vaccine Preventable Diseases.



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INTRODUCTION

- Vaccines provide immunity against infectious diseases.
- The vaccine-preventable diseases of focus in this project are measles, mumps, and pertussis.
 - Each of the three diseases were near full eradication after their vaccines were introduced in the US.
- Measles, mumps, and pertussis are classified as respiratory tract infections.
 - Infected individuals are at risk for hospitalizations, encephalitis, and possibly death.
- More recently, there has been an increase in the number of reported cases for these diseases each year in the US.
 - This increase in cases is believed to be associated with an increase in vaccine refusals.
 - The vaccine refusal rate has increased from 2.5% to 4.2% in the span of three years.
- Although the percent increase of vaccine refusals appears to be small, this increase is significant enough to affect the herd immunity within US communities.
- People are refusing to vaccinate because of multiple reasons:
 - Religious Reasons
 - Personal Beliefs
 - Safety Concerns
 - Mistrust (due to the lack of information).

Table 1. Reduction in the morbidity rate of infectious diseases after the introduction of the associated vaccines in the US. Table adapted from Ventola 2017.

Disease	Reduction
Diphtheria	100%
Measles	99.9%
Paralytic poliomyelitis	100%
Rubella	99.9%
Congenital rubella syndrome	99.3%
Smallpox	100%
Mumps	95.9%
Tetanus	92.9%
Pertussis	92.2%

METHODS

A total of 84 studies, reviews, and reports are included in this project. These papers discuss information regarding common childhood diseases and the vaccines associated with each.

RESULTS

Table 2. Percentage of infants in the United States receiving the Tdap and MMR vaccines. Depicted below is the percentage of infants born in 2010, 2011, 2012, or 2013 that have received the Tdap and MMR vaccines. The last column shows the percent change from 2010 to 2013. Table adapted from Blue Cross Blue Shield.

Vaccine	Born in 2010	Born in 2011	Born in 2012	Born in 2013	Percent Change from 2010 to 2013
Tdap (3 doses)	87.4%	89.3%	90.4%	92.0%	5.2%
Tdap (4 doses)	76.6%	79.2%	80.9%	83.4%	8.9%
MMR (1 dose)	87.2%	88.7%	90.0%	91.1%	4.6%

Table 3. Number of reported cases per year of measles, mumps, and pertussis before the vaccine, after the vaccine, and in the past few years. In parentheses is the year these cases were reported. Information obtained from CDC 2020 Nov 5; Liang et al. 2018; Mumps 2019; Measles --- United States, 2000.

Disease	Before the Vaccine	After the Vaccine	Past Few Years
Measles	4 million	86 (2000)	1,274 (2019)
Mumps	186,000	231 (2003)	6,109 (2017)
Pertussis	200,000	1000 (1976)	18,617 (2019)

Table 4. Vaccine refusal rates in seven states in the US and recent outbreaks that have occurred. Shown is the percent of vaccine refusals in seven states and recent outbreaks that have occurred in these states. Information obtained from Blue Cross Blue Shield; Mumps 2019; Measles 2019; Measles Outbreaks 2019; Newsroom 2013; Dutta 2020; Michigan Measles Outbreak Information 2019.

State	Vaccine Refusal Rates	Outbreaks (Year)
Ohio	2.2%	Measles (2022)
California	2.3%	Measles (2010)
Michigan	5.4%	Measles (2019)
Colorado	5.7%	Mumps (2019)
Arizona	6.4%	Pertussis (2013)
Oregon	6.8%	Measles (2019)
Washington	7.0%	Measles (2019)
New York	8.4%	Mumps (2009)

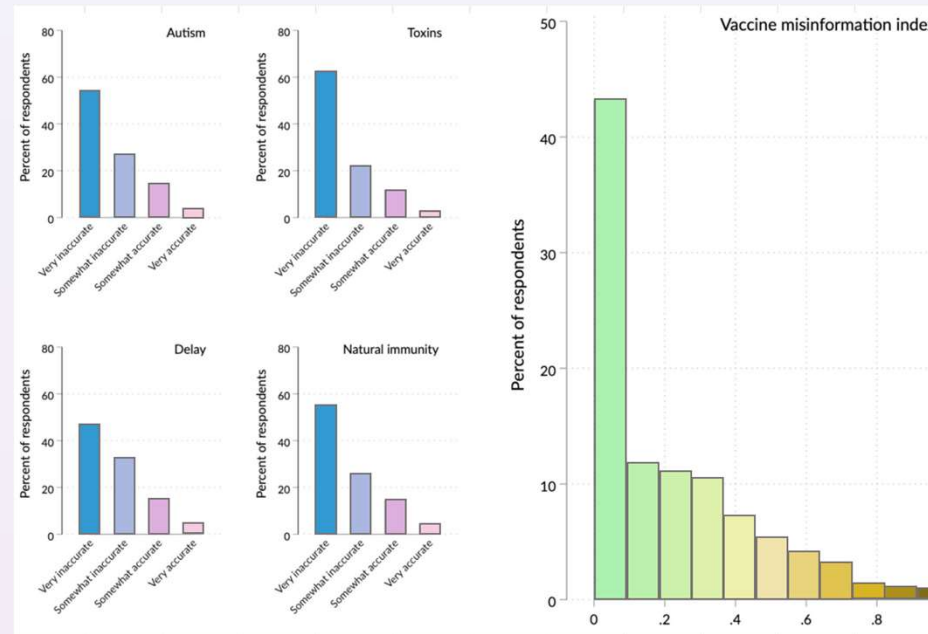


Figure 1. The percent of 2,500 respondents who believe in vaccine misinformation. Respondents were asked about their views regarding 4 common false claims of vaccines: (A) vaccines can cause autism, (B) vaccines contain toxins, (C) there is no risk with receiving vaccines later than the CDC recommendations, and (D) developing natural immunity after infection is more effective than vaccines. The responses were then placed on a 4-point scale: 1) very inaccurate, 2) somewhat inaccurate, 3) somewhat accurate, and 4) very accurate. (E) All of the responses were then averaged into a continuous index from 0 to 1. Image adapted from Stecula et. al (2020).

CONCLUSION

- There has been a small increase of the number of infants across the United States receiving the Tdap and MMR vaccines from 2010 to 2013.
 - However, if individual states are analyzed it is evident that there has been outbreaks of measles, mumps, or pertussis in states with a vaccine refusal rate ranging from 2% to 8%.
- There has been an increase in the number of reported cases of measles, mumps, and pertussis.
 - The source of the outbreaks of measles and pertussis were found to have been an unvaccinated individual and these diseases had spread rapidly in communities with low vaccination rates.
 - This suggests that there is a possible positive correlation between vaccine refusal rates and outbreaks of measles and pertussis.
 - However, there is little information regarding the positive correlation between MMR vaccine refusals and the recent outbreaks of mumps.
- Individuals who are receiving news from social media outlets are more likely to believe in false claims concerning vaccines.
 - Considering the spread of misinformation on social media is a driving factor for vaccine refusals, information supporting vaccines should be widespread on social media platforms.
- As the outbreaks in the United States continue to increase over the years, it has become increasingly important for parents to vaccinate their children.

FUTURE DIRECTIONS

- More studies need to be done to further analyze the relationship between vaccine misinformation and the increase in outbreaks of that particular disease.
- More studies need to be conducted to further evaluate the possible positive correlation between MMR vaccine refusals and mumps outbreaks.
- More studies need to be conducted to further evaluate the effect different social media platforms have on vaccine refusals in order to effectively combat this.

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