Formal Debates to Clarify Intro Stats Objectives

Dan Schafer
Dept. of Statistics, Oregon State University
stat.oregonstate.edu/people/schafer

Examples of Evidence-Intensive Debate Topics

Resolved:

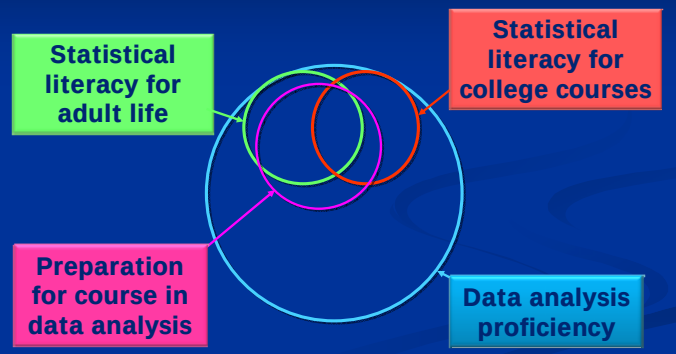
1. That gun restriction laws deter crime
2. That vaccinations should be compulsory
3. That "abstinence only" sex education works

2

4. That health insurance should cover complementary & alternative medicine
5. That government should provide education vouchers
6. That the death penalty reduces violent crime

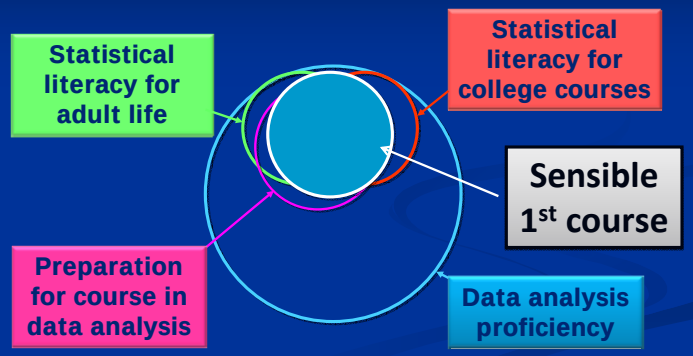
3

Possible Goals of Intro Stats



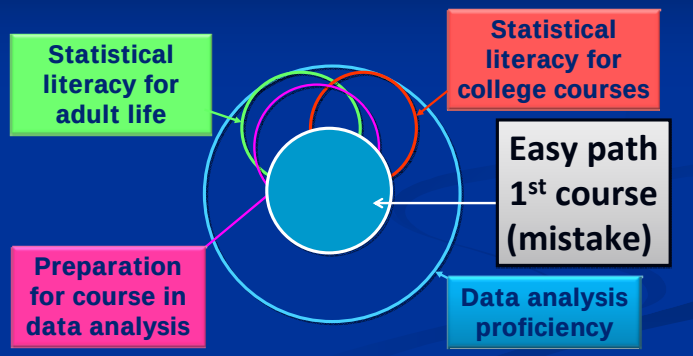
4

Possible Goals of Intro Stats



5

Possible Goals of Intro Stats



6

"Statistical Arguments"

1. Argument: a conclusion along with its evidence and reasoning
2. Statistics: the science and craft of drawing **conclusions** from numerical evidence (using inductive reasoning)

7

An Example of a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

8

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Con

"Highly suggestive" is not proof

9

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Pro

This is one of many studies that show an effect

Con

"Highly suggestive" is not proof

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Pro

This is one of many studies that show an effect

Con

Most are observational; health is obvious confounder

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Pro

Some are randomized experiments

Con

Most are observational; health is obvious confounder

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Pro

Some are randomized experiments

Con

Most not placebo-controlled; placebo effect is likely

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Pro

The one above *is* placebo-controlled

Con

Most not placebo-controlled; placebo effect is likely

An Example of Debate about a Statistical Conclusion

These data provide highly suggestive evidence that adults who take echinacea have fewer colds than those who don't (p-value = 0.03).

Pro

The one above *is* placebo-controlled

Con

This one selected as most significant; "Publication Bias" Fallacy

Resolved: That Vaccination Should be Compulsory

ARGUMENTS IN FAVOR OF THE PROPOSITION
INTRODUCTION

For the benefit of individuals and society, vaccination against specific diseases should be mandatory except for people deemed likely to experience severe side effects. Vaccinations ha been shown to eliminate or significantly curtail smallpox, polio, bacterial meningitis, diphtheri measles, mumps, pertussis, rubella, hepatitis B and chicken pox. These are diseases that can ca tremendous suffering and death, as well as an economic burden to society through the cost of health care and the disruption to normal commerce. Vaccinations are not 100% effective in preventing disease and they can produce side effects, but the benefits to individuals and society outweigh the risks. According to the U.S. Centers for Disease Control, vaccinating all U.S. children born in a given year from birth to adolescence would prevent about 14 million cases disease and save an estimated 33,000 lives (Park, 2008). In order to achieve the individual and societal benefits of total eradication of a disease, the vaccinations must be used by all eligible people, not just some. For this reason, vaccination should be compulsory.

In our argument, we will provide evidence that vaccination reduces disease, that the risks and costs of side effects are small compared to the risks and costs of the epidemics that would resu the absence of vaccination, that decliners cause injury not only to themselves but also others, that it is therefore unethical *not* to make vaccination compulsory.

We start with small pox, a terrible infectious disease that causes death in 80% of children affected (Riedel, 2005) and blindness in 65% to 85% of the survivors (Jezek, 1981). At one point in history, one in seven children in Europe died from small pox (Fenner, et al, 1988). In the 19th century, an estimated 300 to 500 million people died from the disease (Koplow, 2003). In 1967, 2 million died from it. After a global vaccination program in the following decade, small pox was eradicated (World Health Organization, 1979).

Another example is measles. In 1958 there were 763,094 cases of measles (Orenstein, et al, 2004) and 552 deaths in the United States (Centers for Disease Control and Prevention, 2008). With the help of new vaccines, the number of cases dropped to fewer than 150 per year (Centers for Disease Control and Prevention, 2008). As evident in Display 1, there is convincing evidence of a decline in the distribution of yearly measles cases in the U.S. since the introduction of the vaccine (p-value < 0.0001; data from Centers for Disease Control and Prevention, 2009). This is one of many examples. Display 2, for another, shows convincing evidence of a decline in Rubella cases since the commencement of vaccination (p-value < 0.0001).

16

Resolved: That Vaccination Should be Compulsory

Arguments In Favor: Introduction

Resolved: That Vaccination Should be Compulsory

ARGUMENTS IN FAVOR OF THE PROPOSITION
INTRODUCTION

For the benefit of individuals and society, vaccination against specific diseases should be mandatory except for people deemed likely to experience severe side effects. Vaccinations have been shown to eliminate or significantly curtail smallpox, polio, bacterial meningitis, diphtheria, measles, mumps, pertussis, rubella, hepatitis B and chicken pox. These are diseases that can cause tremendous suffering and death, as well as an enormic burden to society through the cost of health care and the disruption to normal commerce. Vaccinations are not 100% effective in preventing disease and they can produce side effects, but the benefits to individuals and society outweigh the risks. According to the U.S. Centers for Disease Control, vaccinating all U.S. children born in a given year from birth to adolescence would prevent about 14 million cases of disease and save an estimated 33,000 lives (Park, 2008). In order to achieve the individual and societal benefits of total eradication of a disease, the vaccinations must be used by all eligible people, not just some. For this reason, vaccination should be compulsory.

In our argument, we will provide evidence that vaccination reduces disease, that the risks and costs of side effects are small compared to the risks and costs of the epidemics that would result in the absence of vaccination, that decliners cause injury not only to themselves but also others, and that it is therefore unethical *not* to make vaccination compulsory.

We start with small pox, a terrible infectious disease that causes death in 80% of children affected (Riedel, 2005) and blindness in 65% to 85% of the survivors (Jezek, 1981). At one point in history, one in seven children in Europe died from small pox (Fenner, et al, 1988). In the 19th century, an estimated 300 to 500 million people died from the disease (Koplow, 2003). In 19[illegible] million died from it. After a global vaccination program in the following decade, small pox was eradicated (World Health Organization, 1979).

Another example is measles. In 1958 there were 763,094 cases of measles (Orenstein, et al, 20[illegible] and 552 deaths in the United States (Centers for Disease Control and Prevention, 2008). With the help of new vaccines, the number of cases dropped to fewer than 150 per year (Centers for Disease Control and Prevention, 2008). **As evident in Display 1, there is convincing evidence of a decline in the distribution of yearly measles cases in the U.S. since the introduction of the vaccine (p-value < 0.0001; data from Centers for Disease Control and Prevention, 2009).** This is one of many examples. Display 2, for another, shows convincing evidence of a decline in Rubella cases since the commencement of vaccination (p-value < 0.0001).

Resolved: That Vaccination Should be Compulsory

Arguments In Favor: Introduction

A statistical argument

17

Resolved: That Vaccination Should be Compulsory

ARGUMENTS IN FAVOR OF THE PROPOSITION
INTRODUCTION

For the benefit of individuals and society, vaccination against specific diseases should be mandatory except for people deemed likely to experience severe side effects. Vaccinations have been shown to [illegible] measles, mump[illegible] tremendous su[illegible] health care and [illegible] preventing dise[illegible] outweigh the ri[illegible] children born i[illegible] disease and sav[illegible] societal benefit[illegible] people, not just

In our argumen[illegible] costs of side ef[illegible] the absence of [illegible] that it is therefo[illegible]

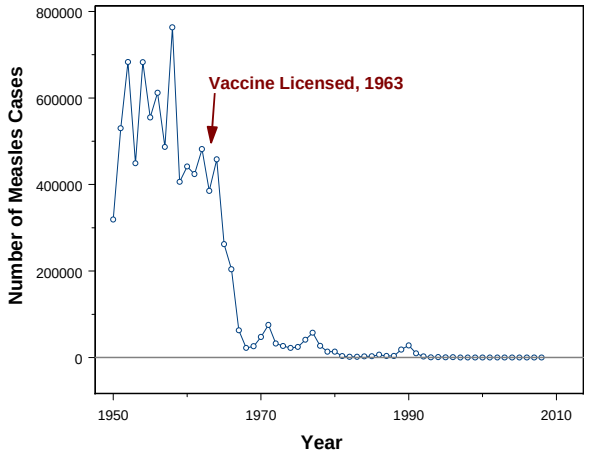
We start with small pox, a terrible infectious disease that causes death in 80% of children affected (Riedel, 2005) and blindness in 65% to 85% of the survivors (Jezek, 1981). At one point in history, one in seven children in Europe died from small pox (Fenner, et al, 1988). In the 19th century, an estimated 300 to 500 million people died from the disease (Koplow, 2003). In 19[illegible] million died from it. After a global vaccination program in the following decade, small pox was eradicated (World Health Organization, 1979).

Another example is measles. In 1958 there were 763,094 cases of measles (Orenstein, et al, 20[illegible] and 552 deaths in the United States (Centers for Disease Control and Prevention, 2008). With the help of new vaccines, the number of cases dropped to fewer than 150 per year (Centers for Disease Control and Prevention, 2008). **As evident in Display 1, there is convincing evidence of a decline in the distribution of yearly measles cases in the U.S. since the introduction of the vaccine (p-value < 0.0001; data from Centers for Disease Control and Prevention, 2009).** This is one of many examples. Display 2, for another, shows convincing evidence of a decline in Rubella cases since the commencement of vaccination (p-value < 0.0001).

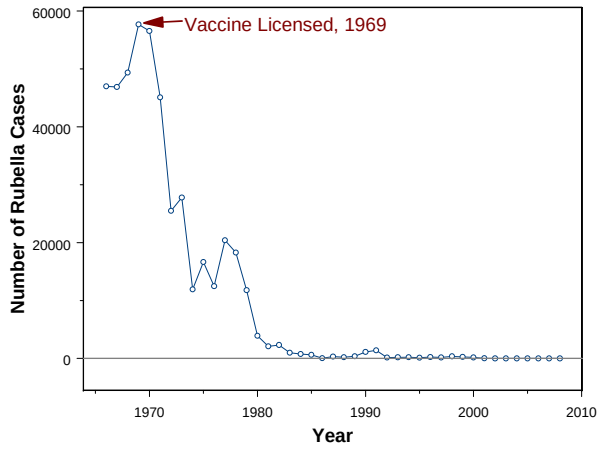
…convincing evidence of a decline in measles since introduction of vaccine (p-value < 0.0001)

A statistical argument

18



19



20

In addition, there is substantial evidence that disease cases have increased in areas where vaccination has been discontinued or reduced. **The Wikipedia article on "vaccination controversy" documents seven countries in which disease has increased after a reductio in vaccination rates. One U.S. study found that non-vaccinated children were 22 times more likely to acquire measles than vaccinated children (95% confidence interval: 16 times to 31 times more likely; Feiken, et al, 2000). A study of 15,351 children in Guinea Bissau, West Africa Mortality showed that the morality rate among those vaccinated w estimated to be 74% of the mortality rate among those who weren't (95% confidence interval 53% to 103%; Kristensen, et al., 2000).**

An interesting feature of the graphs in Displays 1 and 2 is the spike around 1989, which corresponds to a time when more parents were declining to get their children vaccinated. **In the case of measles, the incidence increased by 423% over the previous year. Of the 7,1 measles cases in the reporting period, about 60% were in people who were not vaccinat (MWWR, 6/1/1990).** Some of these cases were children whose parents declined vaccinatio but some were children who were too young to be vaccinated or who could not be vaccinate due to medical conditions. This highlights a very important point: The choice to decline vaccination affects not just that child but also children who are too young or otherwise deem medically unsuitable for vaccination. Because of a critical mass of disease incidence among the decliners, it also causes disease in some who are vaccinated (because the vaccination is not 100% successful) who would not otherwise have been exposed to the disease. Eradication can only be accomplished with full compliance among those eligible to be vaccinated.

The costs of not vaccinating are enormous compared to the costs of treating the illnesses they prevent. In 2001, routine childhood immunizations against seven diseases were estimated to save over $40 billion per birth-year cohort in the U.S. (Zhou, et al., 2005).

With these arguments, we have shown that vaccination is effective in preventing disease, that decliners can cause adverse effects—in terms of health and economics—not just upon themselves but upon others, and that full compliance of vaccination can lead to disease eradication. For these reasons, it is morally imperative that vaccination be compulsory.

Arguments In Favor: Introduction (continued)

Statistical arguments in color

21

The Wikipedia article on "vaccination controversy" documents seven countries in which disease increased after vaccination rates decreased. This provides strong evidence that an increase in disease occurs more often than a decrease after a reduction in vaccination rate (p-value = 0.008)

22

A study of 15,351 children in West Africa showed that mortality rate among vaccinated children was estimated to be 74% of the mortality among un-vaccinated children (95% confidence interval 53% to 103%; Kristensen, et al., 2000).

23

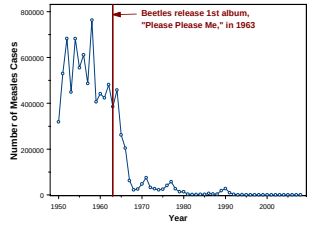
ARGUMENTS AGAINST THE PROPOSITION
INTRODUCTION

The evidence that vaccines are effective is flawed and exaggerated. There is, however, strong evidence of serious side effects, sometimes with higher probability and with more serious health consequences than the disease itself. Compulsory vaccination causes great profits for pharmaceutical companies, who consequently have great incentive to overstate the benefits of compulsory vaccination and understate the risks. Making vaccines compulsory violates freedoms that we hold dear. Since we know there is a chance that vaccination can cause death or permanent disability, it is unethical to force people to take it.

The evidence from observational studies in Displays 1 and 2 is unpersuasive. We have made minor changes to these graphs—in Displays 3 and 4—to demonstrate that the effect of the year of the vaccine introduction is confounded with the effect of everything else that happened in that year. **Note, for example, that there is convincing evidence that the median number of measles cases per year decreased after the Beetles released their first album "Please Please Me" in 1969 (p-value < 0.0001). Does that mean that the album caused a decrease in measles cases? No, of course not. This demonstrates that the effect of the measles vaccine is confounded with everything else that changed at about that time, and provides no proof that the vaccine is responsible for disease reduction.**

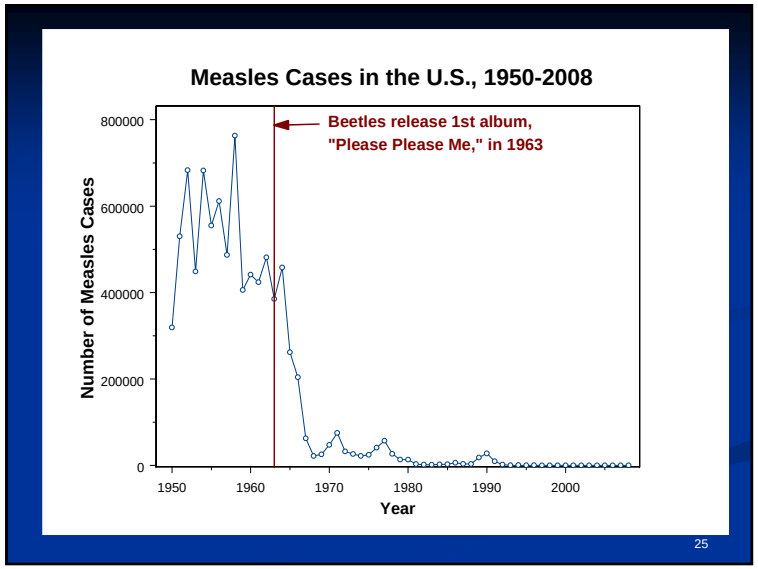
Display 3

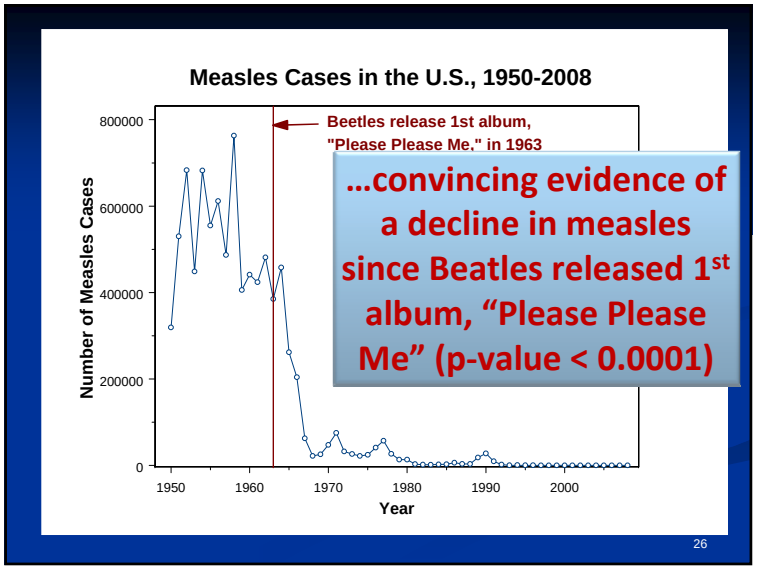
Measles Cases in the U.S., 1950-2008

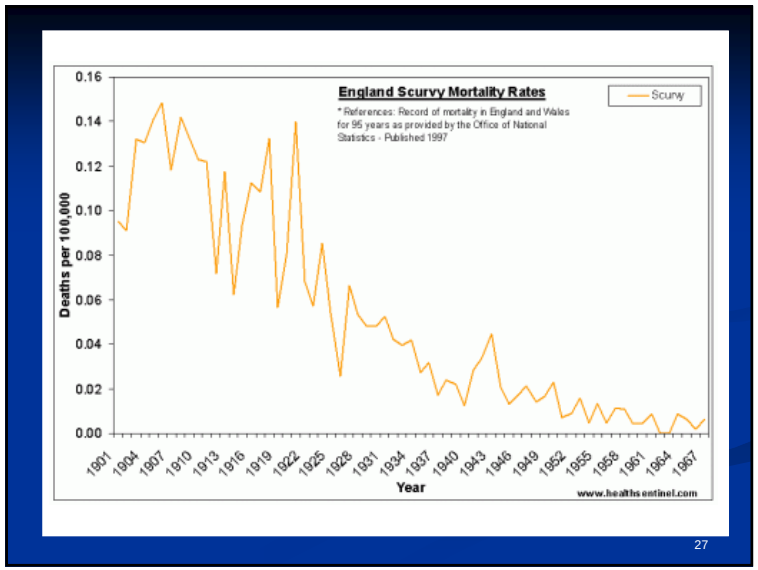


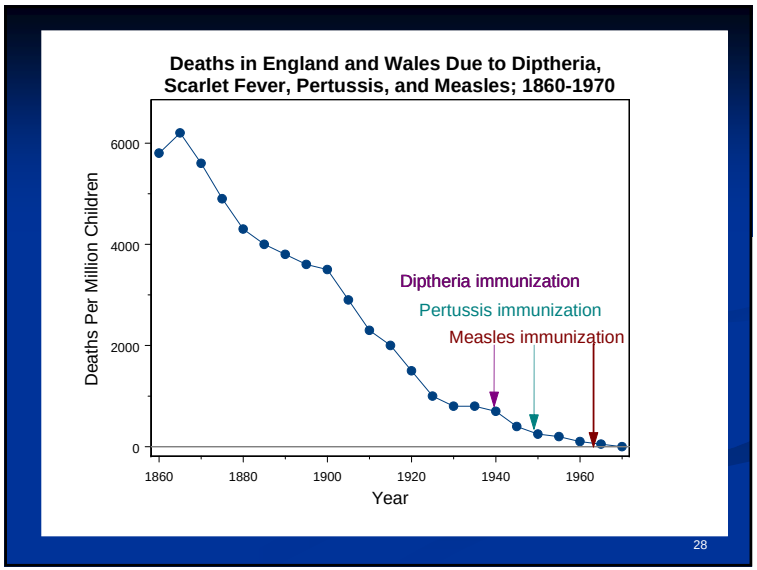
Arguments Against: Introduction

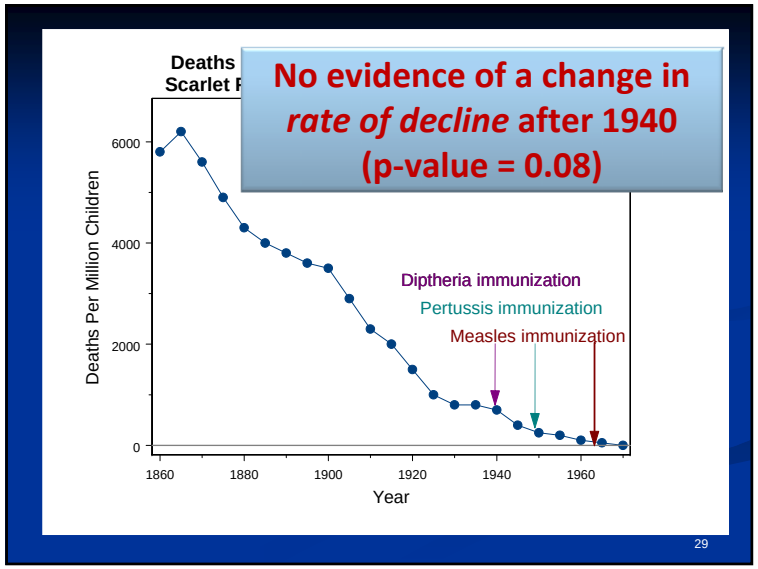
24

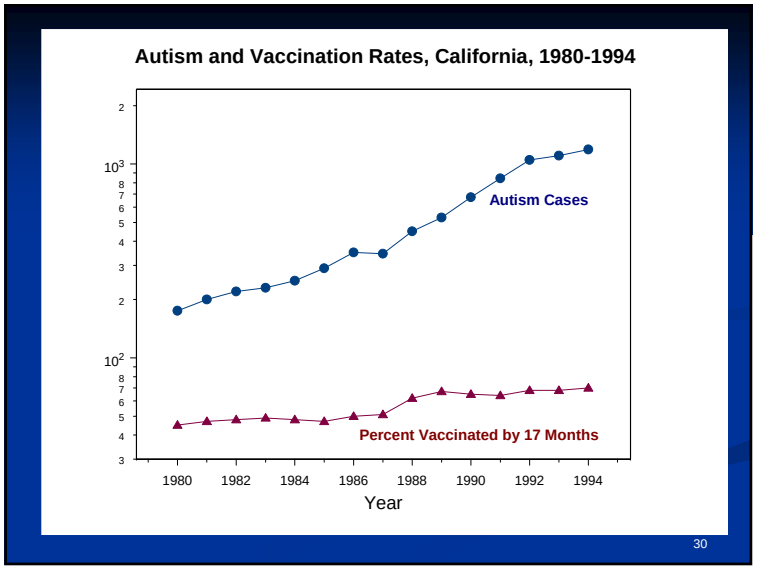

Measles Cases in the U.S., 1950-2008
Beetles release 1st album,
"Please Please Me," in 1963
Number of Measles Cases
800000
600000
400000
200000
0
1950
1960
1970
1980
1990
2000
Year
25

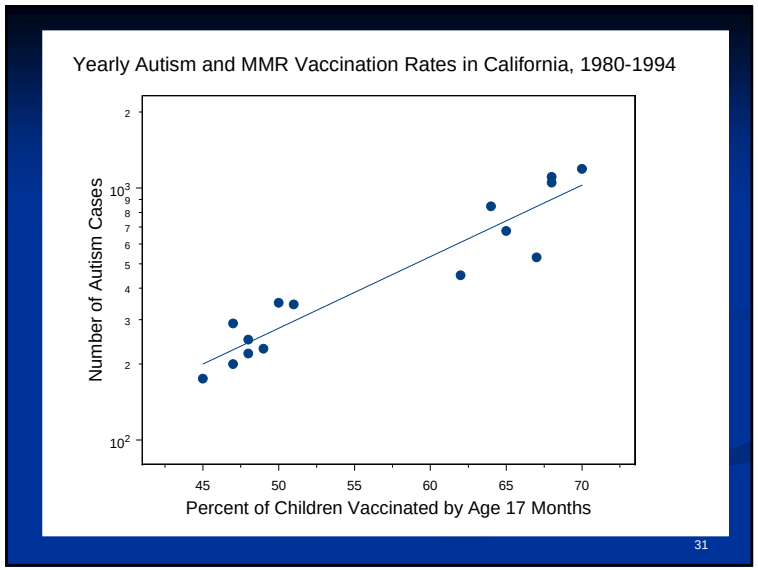

Measles Cases in the U.S., 1950-2008
Beetles release 1st album,
"Please Please Me," in 1963
…convincing evidence of a decline in measles since Beatles released 1st album, "Please Please Me" (p-value < 0.0001)
Number of Measles Cases
800000
600000
400000
200000
0
1950
1960
1970
1980
1990
2000
Year
26

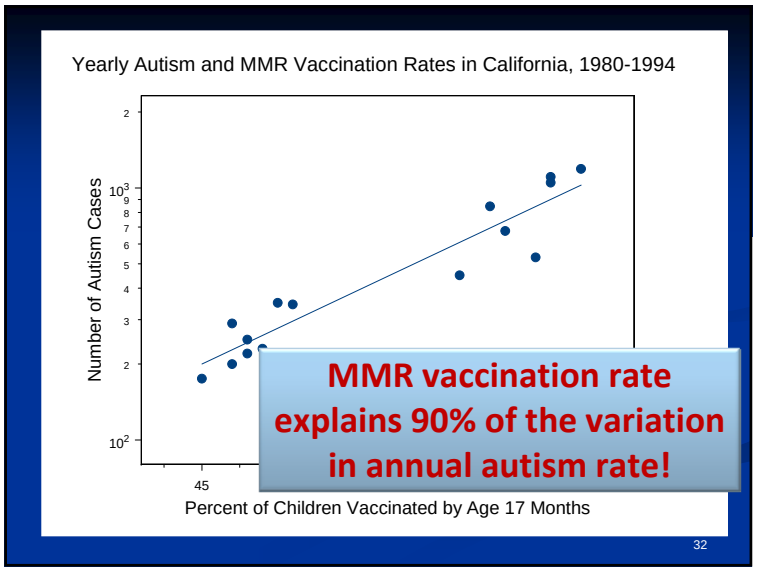

England Scurvy Mortality Rates
* References: Record of mortality in England and Wales for 95 years as provided by the Office of National Statistics - Published 1997
Scurvy
Deaths per 100,000
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1901
1904
1907
1910
1913
1916
1919
1922
1925
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
Year
www.healthsentinel.com
27


Deaths in England and Wales Due to Diptheria, Scarlet Fever, Pertussis, and Measles; 1860-1970
Deaths Per Million Children
6000
4000
2000
0
Diptheria immunization
Pertussis immunization
Measles immunization
1860
1880
1900
1920
1940
1960
Year
28


Deaths
Scarlet F
No evidence of a change in
rate of decline after 1940
(p-value = 0.08)
Deaths Per Million Children
6000
4000
2000
0
1860
1880
1900
1920
1940
1960
Year
Diptheria immunization
Pertussis immunization
Measles immunization
29

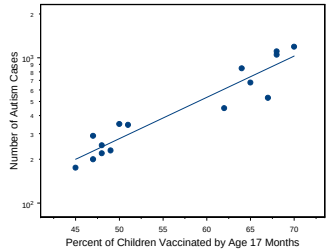

Autism and Vaccination Rates, California, 1980-1994
Autism Cases
Percent Vaccinated by 17 Months
1980
1982
1984
1986
1988
1990
1992
1994
Year
30


Yearly Autism and MMR Vaccination Rates in California, 1980-1994
Number of Autism Cases
45
50
55
60
65
70
Percent of Children Vaccinated by Age 17 Months
31


Yearly Autism and MMR Vaccination Rates in California, 1980-1994
Number of Autism Cases
MMR vaccination rate
explains 90% of the variation
in annual autism rate!
45
Percent of Children Vaccinated by Age 17 Months
32

Display 7

Yearly Autism and MMR Vaccination Rates in California, 1980-1994



The vaccination for diphtheria, pertussis, and tetanus (DPT) is also dangerous. The part of the DPT vaccine that carries the greatest side effects is the pertussis (whooping cough) part. **From a large case-control study of British children, it was estimated that the odds of death or physiological, behavioral, neurological or physical dysfunction was 5.5 times greater in children who had the diphtheria, tetanus, and pertussis (DPT) vaccination than for those who didn't (95% confidence interval: 1.6 times to 23.7 times greater; Miller et al., 1993). The incidence rate of pertussis in the U.S. is about 5 cases per 100,000 people and the mortality rate among those who get it is 1 in 500, which implies that the probability of dying from pertussis in the U.S. is 1 in ten million. The probability of a serious adverse reaction to the vaccination is 1 in 140,000.**

These arguments have shown that the tradeoff between the risks of disease and the risks of serious adverse effects of vaccination is not as obviously one-sided as the pharmaceutical industry wants us to believe. The government should not force individuals to take the government's gamble. Each individual should be allowed to make the gamble on their own. As with what we eat and drink, we should be given autonomy over our own bodies.

33

Arguments Against: Introduction (continued)

Statistical arguments in color

From a large case-control study…, the odds of death or major dysfunction for children who had the DPT vaccination was estimated to be 6 times as large as the odds for those who didn't (95% confidence interval: 1.6 times to 23.7 times as large; Miller et al., 1993).

34

ARGUMENTS IN FAVOR OF THE PROPOSITION
REBUTTAL

The Volvo Fallacy, also known as the Fallacy of Misleading Vividness, is committed when an individual bases a decision on a rare but vivid anecdote despite statistical evidence that the decision is unwise—such as a man deciding for safety reasons not to buy a Volvo, despite it's positive record of safety, because he heard about a Volvo whose wheel fell off on a highway, leading to a fiery and fatal crash. The human mind tends to place undue weight on the vivid image at the expense of rational evaluation of statistics. The anti-vaccination movement is driven by the Volvo Fallacy in this way: Since disease rates are now low, people don't tend to have relatives or neighbors with polio, and we don't hear news reports about children suffering or dying from pertussis. We do, however, hear anecdotes about children who get autism after receiving vaccinations. The terrifying image of the possibility of a vaccination-autism links causes some parents to misjudge the overwhelming statistical evidence that the consequences of non-vaccination are much worse than the consequences of vaccination.

The anti-vaccination side states that the evidence for the effectiveness of vaccines is from observational studies and therefore not proof that the vaccine causes the reduction in mortality rate. The observational evidence is, however, consistent with the proposition that the vaccine works. Further, unlike the release of the Beetles album, there is a scientific theory by which the vaccine is expected to work and there is also evidence that the change in disease incidence in a country responds to changes in vaccination rates. There is, therefore, a preponderance of observational evidence that is consistent with the hypothesis that vaccinations are effective. In addition, there are *randomized experiments* showing that vaccines *caused* a reduction in disease rates.

In the Salk polio vaccine trials of 1954, for example, researchers randomly assigned children to receive a polio vaccine or placebo. Of the 200,745 vaccinated children, 82 got polio. Of the 201,229 placebo-treated children, 162 got polio. These data provide overwhelming evidence that the vaccine *caused* a reduction in polio probability (1-sided p-value = 0.0000001). The odds of getting polio were estimated to be 97% greater for those who receive placebo than for those who receive the vaccine (95% confidence interval: 51% to 157% greater).

A meta analysis of randomized experiments on the pertussis vaccine carried out between the 1930s and 1950s, as another example, showed that the odds of pertussis for placebo users were estimated to be 4.5 times as great as for those who received the vaccine (95% confidence interval: 3.8 times to 5.6 times greater; Jefferson, 2006).

35

Arguments in Favor: Rebuttal

Statistical arguments in color

ARGUMENTS IN FAVOR OF THE PROPOSITION
REBUTTAL

The Volvo Fallacy, also known as the Fallacy of Misleading Vividness, is committed when an individual bases a decision on a rare but vivid anecdote despite statistical evidence that the decision is unwise—such as a man deciding for safety reasons not to buy a Volvo, despite it's positive record of safety, because he heard about a Volvo whose wheel fell off on a highway, leading to a fiery and fatal crash. The human mind tends to place undue weight on the vivid image at the expense of rational evaluation of statistics. The anti-vaccination movement is driven by the Volvo Fallacy in this way: Since disease rates are now low, people don't tend to have relatives or neighbors with polio, and we don't hear news reports about children suffering or dying from pertussis. We do, however, hear anecdotes about children who get autism after receiving vaccinations. The terrifying image of the possibility of a vaccination-autism links causes some parents to misjudge the overwhelming statistical evidence that the consequences of non-vaccination are much worse than the consequences of vaccination.

The anti-vaccination side states that the evidence for the effectiveness of vaccines is from observational studies and therefore not proof that the vaccine causes the reduction in mortality rate. The observational evidence is, however, consistent with the proposition that the vaccine works. Further, unlike the release of the Beetles album, there is a scientific theory by which the vaccine is expected to work and there is also evidence that the change in disease incidence in a country responds to changes in vaccination rates. There is, therefore, a preponderance of observational evidence that is consistent with the hypothesis that vaccinations are effective. In addition, there are *randomized experiments* showing that vaccines *caused* a reduction in disease rates.

In the Salk polio vaccine trials of 1954, for example, researchers randomly assigned children to receive a polio vaccine or placebo. Of the 200,745 vaccinated children, 82 got polio. Of the 201,229 placebo-treated children, 162 got polio. These data provide overwhelming evidence that the vaccine *caused* a reduction in polio probability (1-sided p-value = 0.0000001). The odds of getting polio were estimated to be 97% greater for those who receive placebo than for those who receive the vaccine (95% confidence interval: 51% to 157% greater).

A meta analysis of randomized experiments on the pertussis vaccine carried out between the 1930s and 1950s, as another example, showed that the odds of pertussis for placebo users were estimated to be 4.5 times as great as for those who received the vaccine (95% confidence interval: 3.8 times to 5.6 times greater; Jefferson, 2006).

36

Volvo Fallacy (Fallacy of Misleading Vividness)

ARGUMENTS IN FAVOR OF THE PROPOSITION
REBUTTAL

The Volvo Fallacy, also known as the Fallacy of Misleading Vividness, is committed when an individual bases a decision on a rare but vivid anecdote despite statistical evidence that the decision is unwise—such as a man deciding for safety reasons not to buy a Volvo, despite it's positive record of safety, because he heard about a Volvo whose wheel fell off on a highway, leading to a fiery and fatal crash. The human mind tends to place undue weight on the vivid image at the expense of rational evaluation of statistics. The anti-vaccination movement is driven by the Volvo Fallacy in this way: Since disease rates are now low, people don't tend to have relatives or neighbors with polio, and we don't hear news reports about children suffering or dying from pertussis. We do, however, hear anecdotes about children who get autism after receiving vaccinations. The terrifying image of the possibility of a vaccination-autism links causes some parents to misjudge the overwhelming statistical evidence that the consequences of non-vaccination are much worse than the consequences of vaccination.

The anti-vaccination side states that the evidence for the effectiveness of vaccines is from observational studies and therefore not proof that the vaccine causes the reduction in mortality rate. The observational evidence is, however, consistent with the proposition that the vaccine works. Further, unlike the release of the Beetles album, there is a scientific theory by which the vaccine is expected to work and there is also evidence that the change in disease incidence in a country responds to changes in vaccination rates. There is, therefore, a preponderance of observational evidence that is consistent with the hypothesis that vaccinations are effective. In addition, there are *randomized experiments* show

In the Salk polio vaccine trials of 1954, for children to receive a polio vaccine or plac polio. Of the 201,229 placebo-treated child overwhelming evidence that the vaccine c p-value = 0.0000001). The odds of getting who receive placebo than for those who re to 157% greater).

A meta analysis of randomized experimen the 1930s and 1950s, as another example, users were estimated to be 4.5 times as gr confidence interval: 3.8 times to 5.6 times greater; Jefferson, 2006).

***Causal* Link from Randomized Experiments. Salk polio vaccine trials (p-value = 0.0000001)**

37

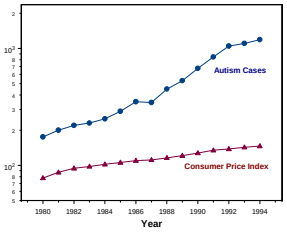
Regarding the link between the MMR vaccine and autism, Wakefield, the lead author of the study was later accused of improper scientific conduct and falsifying the data. Ten of the thirteen authors of [illegible] causal link public hea diseases, a considere estimated probabilit large). Th causes aut

Wakefield's MMR vaccine-autism link: Prosecutor's Fallacy!

In claiming a connection between MMR vaccination and Autism with Displays 6 and 7, the anti-vaccination side is committing the fallacy of over-interpreting spurious correlation. They claim that the high correlation of MMR and autism in California implies a causal link. But the spurious correlation of variables that change over time is a more likely explanation. If there is one variable that increases by about 5% per year and another than also increases by about 5% per year, then they will be very highly correlated, even if there is absolutely no causal relationship. In Display 8, below, for example, we have shown the California annual autism counts along with the U.S. consumer price index at the beginning of the year. Although a causal link between these two variables is preposterous, the consumer price index can explain 89% of the variation in autism incidence—essentially identical in its explanatory power to MMR vaccination rates.

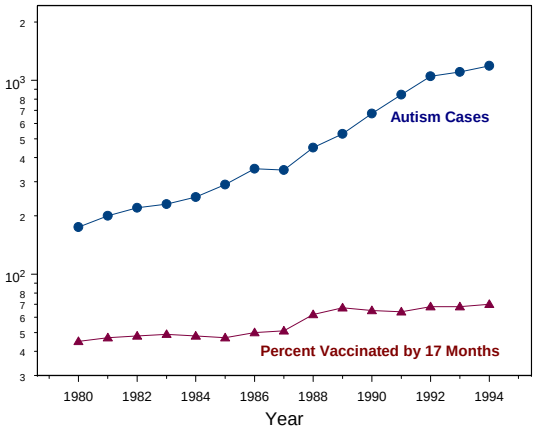
Display 8

U.S. Consumer Price Index and Autism in California



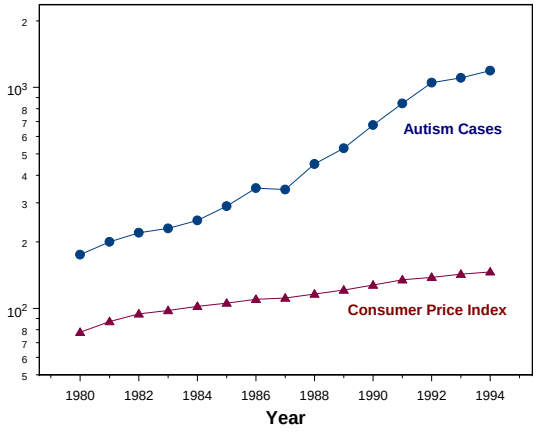
38

Autism and Vaccination Rates, California, 1980-1994



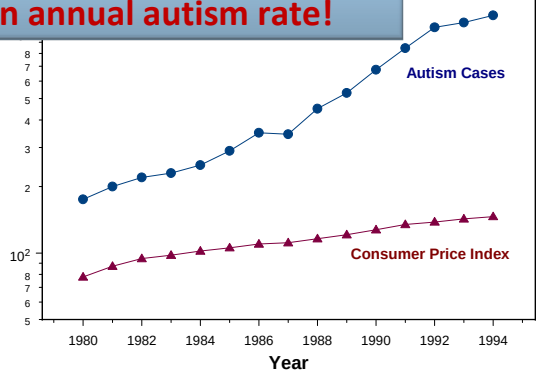
39

U.S. Consumer Price Index and Autism in California



40

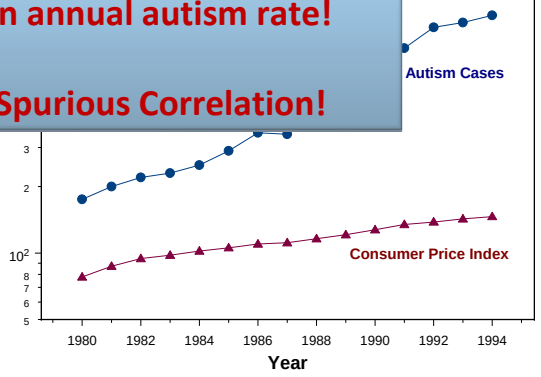
Consumer Price Index explains 90% of the variation in annual autism rate!



41

Consumer Price Index explains 90% of the variation in annual autism rate!

Spurious Correlation!

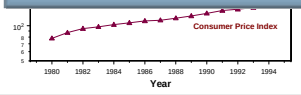


42

Regarding the link between the MMR vaccine and autism, Wakefield, the lead author of the study was later accused of improper scientific conduct and falsifying the data. Ten of the thirteen authors of the original paper wrote a retraction of the conclusion that there was evidence of a causal link public hea diseases, a considered estimated probabilit large). The causes aut

In claiming vaccinatio that the hi correlation that increa they will h below, for consumer variables i incidence-

A Danish study of 537,000 children estimated the probability of autism in vaccinated children to be only 92% as large as the probability of autism in unvaccinated children (95 percent confidence interval: 68% to 124% as large). The authors concluded that this was strong evidence against the hypothesis that MMR causes autism (Madsen et al, 2002).



43

ARGUMENTS AGAINST THE PROPOSITION
REBUTTAL

As evidence that disease has increased when vaccination rates have been reduced, the pro-vaccination side reported seven occurrences of disease rate increasing in response to reduced vaccination rates, as reported in the Wikipedia article on vaccination controversy. There is no indication, however, that these seven occurrences are a random sample of a population of changes in vaccination rates. There is every reason to believe that they were selected because they showed what the authors wanted to show. This is like claiming that cigarettes have no affect on health by finding seven smokers who lived long lives. The argument is anecdotal and should not be taken seriously.

The pro-vaccination side claims that anti-vaccination advocates are committing the Volvo Fallacy by succumbing to fears brought on by stories of serious side effects at the expense of considering statistical evidence. We reject this argument. Instead, we say we are simply interpreting the statistical evidence correctly.

The pro-vaccination side argued that there is evidence of a causal connection between vaccinations and reduction in disease rates from randomized experiments, but these are experiments that were performed 60 to 80 years ago and their use for today's populations requires unverifiable extrapolation beyond the populations on which they were based.

The pro-vaccination side reported the conclusion from the Danish study of 537,000 children as strong evidence against the hypothesis that MMR causes autism. With this conclusion, they committed the Fallacy of Accepting the Null Hypothesis. In fact, the Danish authors report a 95% confidence interval for relative risk of 68% to 124%. While the data are consistent with an equal risk of autism in vaccinated and un-vaccinated populations, they are also consistent with the hypothesis that the risk of autism for vaccinated children is 124% of the risk for non-vaccinated children. The pro vaccination side consistently commits the Fallacy of Accepting the Null Hypothesis by incorrectly interpreting "no evidence of an association of MMR and autism" as "evidence of no association of MMR and autism."

Arguments Against: Rebuttal

Statistical arguments in color

44

The Wikipedia article on "vaccination controversy" documents seven countries in which disease increased after vaccination rates decreased.

Anecdotal! Biased sampling.

45

A Danish study of 537,000 children estimated the probability of autism in vaccinated children to be only 92% as large as the probability of autism in unvaccinated children (95 percent confidence interval: 68% to 124% as large). The authors concluded that this was strong evidence against the hypothesis that MMR causes autism (Madsen et al, 2002).

Fallacy of Accepting the Null!

46

Topics That Arose in this Debate

1. P-values/confidence intervals
2. Obs. studies/randomized experiments/causation
3. Anecdotal evidence/biased sampling
4. Publication bias; fishing for significance
5. Volvo Fallacy
6. Spurious correlation
7. Accumulation of evidence
8. Statistical/practical significance

47

Conclusions

1. A possible learning objective: learn tools and skills for participating in evidence-based debates
2. A possible tool for teaching and assessing statistical literacy topics: scripted debates

stat.oregonstate.edu/people/schafer

48