Formal Debates to Clarify Intro Stats Objectives

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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

Possible Goals of Intro Stats

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

- Statistical literacy for adult life
- Statistical literacy for college courses
- Data analysis proficiency
- Preparation for course in data analysis
- Sensible 1st course

“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)

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).
An Example of Debate about a Statistical Conclusion

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Some are randomized experiments

Most are observational; health is obvious confounder
Resolved: That Vaccination Should be Compulsory

Arguments in Favor: Introduction

For the benefit of individuals and society, vaccination against specified diseases should be mandatory except for those deemed unlikely to experience severe side effects. Vaccination has been shown to eliminate or significantly curtail smallpox, polio, bacterial meningitis, diphtheria, tetanus, whooping cough, rubella, hepatitis B and chicken pox. These are diseases that can cause tremendous suffering and death, as well as an economic burden to society through the cost of disease and the disruption to society caused by the loss of healthy workers. Vaccination can prevent millions or billions of dollars in medical costs and personal suffering and loss, and it can reduce side effects, but the benefits to individuals and society far outweigh the risks. The vaccination of all children and adults in the United States is an estimated $100 billion in health savings per year (Centers for Disease Control and Prevention, 2008). In order to achieve the individual and societal benefits of vaccination, 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 diseases that would occur if the vaccinations were not used by all eligible people, and that the benefits of vaccination are far greater than the risks. 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). Display 3, for another, shows convincing evidence of a decline in smallpox cases since the commencement of vaccination (p-value < 0.0001).

We want to make it clear that people who are allergic to vaccines or who have other medical conditions that make them unlikely to experience severe side effects should be excluded from mandatory vaccination. We also want to ensure that people have the right to refuse vaccination, but we believe that the benefits to society far outweigh the risks to individuals. For this reason, vaccination should be compulsory.

In conclusion, we believe that vaccination is an effective and cost-effective way to reduce the burden of disease and suffering, and it is essential to the health of individuals and society. For these reasons, we believe that vaccination should be compulsory.

Arguments Against: Introduction

For the benefit of individuals and society, vaccination against specified diseases should not be mandatory. Vaccination has been shown to reduce the burden of disease, and it can reduce the cost of disease and disruption to society caused by the loss of healthy workers. Vaccination can prevent millions or billions of dollars in medical costs and personal suffering and loss, and it can reduce side effects, but the benefits to individuals and society far outweigh the risks. The vaccination of all children and adults in the United States is an estimated $100 billion in health savings per year (Centers for Disease Control and Prevention, 2008). In order to achieve the individual and societal benefits of vaccination, 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 diseases that would occur if the vaccinations were not used by all eligible people, and that the benefits of vaccination are far greater than the risks. 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). Display 3, for another, shows convincing evidence of a decline in smallpox cases since the commencement of vaccination (p-value < 0.0001).

We want to make it clear that people who are allergic to vaccines or who have other medical conditions that make them unlikely to experience severe side effects should be excluded from mandatory vaccination. We also want to ensure that people have the right to refuse vaccination, but we believe that the benefits to society far outweigh the risks to individuals. For this reason, vaccination should be compulsory.

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Resolved: That Vaccination Should be Compulsory

**ARGUMENTS IN FAVOR OF THE PROPOSITION:**

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 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 far outweigh the risks. 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 unethical not to make vaccination compulsory.

We start with small pox, a terrible infectious disease that causes death in 30% of children infected (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 500 to 550 million people died from the disease (Boyland, 2010). In 1979, the World Health Organization declared small pox eradicated (World Health Organization, 1979).

Another example is measles. In 1958 there were 760,094 cases of measles in the United States (Centers for Disease Control and Prevention, 2009). Without the help of new vaccines, the number of cases dropped to fewer than 10 per year (p-value < 0.0001; data from Centers for Disease Control and Prevention, 2009). As evident in Display 1, there is convincing evidence of a decline in the distribution of yearly measles cases 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).
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 reduction in vaccination rates. One U.S. study found that unvaccinated children were 21 times more likely to acquire measles than vaccinated children (95% confidence interval: 16 to 31; Feiken, et al., 2000). A study of 15,351 children in Guinea-West Africa. Mortality increased that the mortality rate among un-vaccinated children was estimated to be 74% of the mortality rate among those who received 100% compliance (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 many parents were deciding to get their children vaccinated. In the case of measles, the incidence increased by 427% over the previous year. Of the 7,149 measles cases in the reporting period, about 60% were in people who were not vaccinated but some were children who were too young to be vaccinated or who could not be vaccinated due to medical conditions. Some of these cases were children whose parents declined vaccination but some were children who were too young to be vaccinated or who could not be vaccinated 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 medically unsuitable for vaccination. Because of a critical mass of disease incidence among the decliners, it also causes disease in others who are vaccinated. Because the vaccination in not 100% successful, this could lead to outbreaks and an increase in the disease. Vaccination can lead to disease.

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 declines can cause adverse effects—victims 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.

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The evidence that vaccines are effective is undisputed. However, vaccine opposition persists for a variety of reasons. One of them is a concern among anti-vaccine advocates about the side effects of vaccines. However, studies have shown that the benefits of vaccination far exceed the risks. The evidence from observational studies in Displays 1 and 2 is overwhelming. The authors state that the effects of vaccination in reducing disease incidence are clear. In 2000, 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 declines can cause adverse effects—victims 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.

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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)

Deaths in England and Wales Due to Diptheria, Scarlet Fever, Pertussis, and Measles; 1860-1970

Diptheria immunization
Pertussis immunization
Measles immunization
No evidence of a change in rate of decline after 1940 (p-value = 0.08)

Autism and Vaccination Rates, California, 1980-1994

MMR vaccination rate explains 90% of the variation in annual autism rate!
Arguments Against: Introduction (continued)

Statistical arguments in color

Display 1

Yearly Autism and MMR Vaccination Rates in California, 1985-1994

Percent of Children Vaccinated by Age 17 Months

- 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).

Arguments in Favor: Rebuttal

Statistical arguments in color

In the Salk polio vaccine trials of 1954, for example, researchers randomly assigned children to receive a vaccine or placebo. Of the 201,229 vaccinated children, 162 got polio. Of the 200,745 placebo-treated children, 82 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).

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Volvo Fallacy (Fallacy of Misleading Vividness)

The Salk polio vaccine trials, for example, showed 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).
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 between the vaccine and MMR. Because the Wakefield study caused such a great public health concern (it lead to the reduction in vaccination rates which lead to increases in diseases, as evident from the spikes around 1990 on Displays 1 and 2), many other studies considered the possible link. The authors concluded that this was strong evidence against the hypothesis that MMR causes autism (Madsen et al, 2002).

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 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. An even more overwhelming statistical evidence that the consequences of non-vaccination are much worse than the consequences of vaccination.

Causal Link from Randomized Experiments. Salk polio vaccine trials of 1954 for children to receive a polio vaccine or placebo. Of the 201,229 placebo-treated children, 162 got polio. Of the 200,745 vaccinated children, 82 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 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).

Prosecutor’s Fallacy!

Wakefield’s MMR vaccine-autism link: Prosecutor’s Fallacy!
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).

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

Anecdotal! Biased sampling.

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Fallacy of Accepting the Null!

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

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

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