# Risks and Odds

# Example 1

Approximately 85% of U.S. Companies test employees and (or job applicants) for drug use. A common inexpensive urine test is the EMIT(enzyme multiplies immunoassay technique) test, which tests for the presence of any five drugs: marijuana, cocaine, amphetamines, opiates, or phencyclidine. Most companies require that positive test results be confirmed by a more reliable GC-MS (gas chromatography mass spectrometry) test.

The following table includes results from 555 adults in the United States.

| | Positive Test Result | Negative Test Results | Total |
|---|---|---|---|
| Subject Uses Drug | 45 | 5 | 50 |
| Subject Does Not Use Drugs | 25 | 480 | 505 |

# Example 2

One of the largest medical experiment ever conducted have found among 200,745 children injected with Salk vaccine, 33 developed paralytic polio. The risk of polio for children treated with the Salk vaccine should be compared to the risk of polio for those children given placebo.

| | Polio | No Polio | Total |
|---|---|---|---|
| Salk Vaccnie | 33 | 200,712 | 200,745 |
| Placebo | 115 | 201,114 | 201,229 |

P(Polio|Salk vaccnine)= $\frac{33}{200,745} = 0.000164$

P(Polio|placebo)= $\frac{115}{201,229} = 0.00571$

# Risk and Odds

| | Disease | No Disease | Total |
|---|---|---|---|
| Treatment | a | b | a+b |
| Placebo | c | d | c+d |

P(Disease|Treatment)= $\frac{a}{a+b}$

P(Disease|placebo)= $\frac{c}{c+d}$

Absolute Risk Reduction=
|P(Disease|Treatment)-P(Disease|placebo)|= $|\frac{a}{a+b}-\frac{c}{c+d}|$

# Relative Risk

$P_t$ : Proportion (incidence rate) of some characteristics in treatment group= P(Disease|Treatment)

$P_c$ : Proportion (incidence rate) of some characteristics in control group=P(Disease|placebo)

$$\text{Relative Risk} = \frac{p_t}{p_c} = \frac{\frac{a}{a+b}}{\frac{c}{c+d}}$$

**Interpretation:** If Relative Risk=1, then the risk is the same for treatment and control group.

If Relative Risk is greater than 1 then the there is greater risk for treatment group.

If Relative Risk is less than 1 then the there is smaller risk for treatment group.

# Relative Risk for Polio Example

$$\text{Relative Risk} = \frac{p_t}{p_c} = \frac{0.000164}{0.000571} = 0.287$$

A Relative Risk less than one indicates that the treatment results in reduced risk. If we consider the reciprocal value i.e.

$$\frac{p_t}{p_c} = \frac{0.000571}{0.000164} = 3.48,$$

we see that patients in placebo group are 3.48 times likely to get polio.

# Odds

| | Disease | No Disease | Total |
|---|---|---|---|
| Treatment | a | b | a+b |
| Placebo | c | d | c+d |

Let $A$ be an event representing an occurance of disease.

Odds in favor of A= $\frac{P(A)}{P(\text{not A})}$

Odds against A= $\frac{P(\text{not A})}{P(A)}$

# Odds Ratio

Let $A$ be an event representing an occurrence of disease in treatment group.

Let $B$ be an event representing an occurrence of disease in control group.

$$\text{Odds in favor of A} = \frac{P(A)}{P(\text{not A})} = \frac{\frac{a}{a+b}}{\frac{b}{a+b}} = \frac{a}{b}$$

$$\text{Odds in favor of B} = \frac{P(B)}{P(\text{not B})} = \frac{\frac{c}{c+d}}{\frac{d}{c+d}} = \frac{c}{d}$$

$$\text{Odds Ratio} = \frac{\text{Odds in favor of A}}{\text{Odds in favor of B}} = \frac{a/b}{c/d} = \frac{ad}{bc}$$

# Odds Ratio: Drug use data

| | Positive Test Result | Negative Test Results | Total |
|---|---|---|---|
| Subject Uses Drug | 45 | 5 | 50 |
| Subject Does Not Uses Drug | 25 | 480 | 505 |

P(Positive Test Results|Subject Uses Drug)$=\frac{45}{50}$

P(Negative Test Results|Subject Uses Drug)$=\frac{5}{50}$

Odds in favor of Positive Test Results$=\frac{45/50}{5/50}=\frac{9}{1}$

This result is often expressed as 9:1. With odds of 9:1 in favor of Positive Test Results for drug test, it follows that the odds against Positive Result for drug test are 1:9.

# Why Not to Use Relative Risk for Retrospective Studies?

- A retrospective study uses existing data that have been recorded for reasons other than research
- Prospective studies plan to collect/evaluate at least some materials that are not yet in existence at the time the research is conceived and submitted for IRB (Institutional review Board) review or exemption.
- Relative Risk makes sense only if involved probabilities are good estimates of the actual incidence rates, as in a prospective study.

**Relative Risk: Prospective Study**

**Odds Ratio: Prospective Study or Retrospective Study**