Jumping into Statistics: Introduction to Study Design and Statistical Analysis for Medical Research Using JMP Pro Statistical Software

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Course Objectives

- Review fundamentals of study design and research methodology
- Understand how to choose best statistical test for your research question
- Practice basic statistical analysis use JMP Pro Software

Course Topics

- Asking a Good Research Question
- Life Cycle of Research and Scientific Method
- Study Design
- Data types and Database Construction
- Descriptive Statistics
- Data Visualization
- Population and Sample, Probability, Statistical Inference
- How to Chose Correct Statistical Method and Run Some Analyses
  - T-tests, ANOVA, Non-Parametric
  - Chi-square, odds ratio, relative risk
  - Regression and Correlation
  - Survival Analysis
  - Test Diagnostics (e.g. sensitivity, specificity, etc.)
- Comparing Statistical Modeling and Machine Learning

Categorical Outcomes and Risk Assessment

Chi-Square Test

Construct contingency table

Risk	Cancer	
	Present	Absent
Smoker	a	b
Non-Smoker	c	d

Compare observed *proportions/frequencies* in each cell to what is expected by chance

For small sample sizes (< 5 in a cell), use **Fisher's exact test**

Also can use a **z-tests** to compare 2 proportions directly (30% vs. 10%)

Odds Ratio

Risk	Cancer	
	Present	Absent
Smoker	a	b
Non-Smoker	c	d

OR→ Ratio of the odds that patients with a risk factor have the disease to the odds that patients without the risk factor have the disease (*likelihood, retrospective*)

$$OR = \frac{a/b}{c/d} = \frac{a\ x\ d}{b\ x\ c}$$

OR = 1, no difference in odds of outcome between groups
OR > 1 → ↑ likelihood
OR < 1 → ↓ likelihood

Relative Risk

Risk	Cancer	
	Present	Absent
Smoker	a	b
Non-Smoker	c	d

RR→ Ratio of the probability of an event occurring in an exposed group to the probability of the event occurring in a comparison, non-exposed group (*risk, prospective)*

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

RR = 1, no difference in risk of outcome between groups

RR > 1 → ↑ risk

RR < 1 → ↓ risk

Relative Risk vs. Odds Ratio

Risk	Cancer	
	Present	Absent
Smoker	a	b
Non-Smoker	c	d

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

- Can only be used when measuring **incidence** (newly defined cases)
- **Prospective**
- Easier to interpret
- **Clinical trials and cohort studies**

$$OR = \frac{a/b}{c/d} = \frac{a\ x\ d}{b\ x\ c}$$

- Commonly used in **case-control** studies and **retrospective** studies
- Calculated in logistic regression or chi-square

Relative risk vs. Odds ratio

Risk	Cancer	
	Present	Absent
Smoker	75 a	25 b
Non-Smoker	25 c	75 d

$$RR = \frac{75/(75+25)}{25/(75+25)} = \frac{0.75}{0.25} = 3$$

$$OR = \frac{75/25}{25/75} = \frac{3}{0.33} \; or \; \frac{75x75}{25x25} = \frac{5,625}{625} = 9$$

More Risk Calculations: Absolute Risk Reduction

Treatment	Postop infection	
	No	Yes
Antibiotic	75	25
Control	25	75

$$RR = \frac{25/(75+25)}{75/(75+25)} = \frac{0.25}{0.75} = .33$$

ARR→ absolute reduction in risk between two groups

$$ARR = \%\ affected\ treatment - \%\ affected\ control$$

$$ARR = 25 - 75 = 50\%\ (decrease\ in\ treatment)$$

More Risk Calculations: Numbers Needed to Treat

Treatment	Postop infection	
	No	Yes
Antibiotic	75	25
Control	25	75

$$\boldsymbol{ARR = 25 - 75 = 50\% \ (decrease \ in \ treatment)}$$

NNT→ number of patients who would have to received treatment/exposure for 1 of them to benefit.

$$\boldsymbol{NNT = \frac{100}{ARR\ (\%)} \text{ or } \frac{1}{ARR}}$$

$$\boldsymbol{NNT = \frac{100}{50\ (\%)} = 2}$$

JMP Demo