An On-line Statistics Course in a Bioethics Curriculum
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Discussion #1: Boiling Water Experiment

The beginning of research is much like being at a buffet - you want to try everything, but neither your plate nor your stomach can hold it all. In empirical research, you have many questions you would like to explore but have limited time and resources to complete your work.

In this discussion you will each design and conduct an experiment to determine the time it takes to bring a pot of water to a boil. Sounds simple. There are many factors that affect the time to boil. Examples of such factors are: the type of stove, starting temperature of the water, the size of the burner, various pot characteristics (thickness, diameter, material), with or without cover, initial volume of water. The objective of this experiment is to practice thinking about all the factors that affect the problem of interest (boiling water) and then actually designing the experiment to meet your resource constraints.

Tasks

1) Design the experiment assuming ideal conditions (e.g., unlimited resources, new pots, etc.). This should include (but is not limited to):

   a) Determine how the boiling state will be determined.
   b) Choose the factors you wish to test.
   c) Set up the experimental protocol. This is the process that will be used to conduct the experiment. Considerations include starting temperature of the water, volume of water to boil, etc.
   d) Determine how many experimental combinations should be run.

2) Given the resources that are available to you for conducting this experiment, modify the ideal experiment to suit your circumstances.

3) Conduct the experiment and record the results. (We will analyze the results later in the term).

Post items 1-3 above as you complete them. Share your lessons learned with your classmates. What unexpected problems did you encounter? Discuss how much your ideal design differed from what you could actually accomplish within your budget. If you had it do again, what would you do differently?

Example Wiki of Empirical Research Terms

Notes:
- The number in parentheses following the term is the number of students who identified that term in the first assignment as being unfamiliar.
- The person contributing the definition affixes their initials following the definition.

Wiki for Empirical Research Terms

adjusted ratio (1) An *adjusted odds ratio is* the odds ratio after taking into account of the influences or correcting for other variables. (JEO)

http://www.abdn.ac.uk/wes2007/Full%20Papers/Stream%20D/296.%20Keming%20Yang%20FP.doc

binary logistic regression (4) A modeling tool for data in which there is a binary response, ie. *yes* (quantified as *1*) or *no* (quantified as *0*). Since modeling a binary response variable with normal linear regression introduces a significant bias into the parameter estimates, it is necessary to use this adjusted model. (JD) (http://statprob.com/encyclopedia/**LogisticModels**?.html)

Chi-squared (X^2) test (2) - most common test for significance of the relationship between categorical variables. The *Chi-square* test becomes increasingly significant as the numbers deviate further from this expected pattern. (BH)

(http://www.statsoft.com/textbook/basic-statistics/#spearson)

collinearity (3) - pairs of explanatory variables in a regression analysis are very highly correlated, i.e. with correlation coefficients very close to +/- 1. (BH)

- Petrie, A. & C. Sabin. (2009) Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: pg 164.

concordance (1) the quality of a bivariate observation data-set, $\{X_1,Y_1\}$ and $\{X_2,Y_2\}$, where:

$$\text{sgn}(X_2 - X_1) \ = \text{sgn}(Y_2 - Y_1)$$

(JD) https://secure.wikimedia.org/wikipedia/en/wiki/Concordant_pair

contamination (1)- in robust statistics, an intentionally inserted set of errors, such as a significantly higher standard deviation, for the purpose of compensating for the poor performance of classical statistical methods when outliers exist. (JD) https://secure.wikimedia.org/wikipedia/en/wiki/Robust_statistics

continuous variable (1) - a numerical variable in which there is no limitation on the values that the variable can take other than that restricted by the degree of accuracy of the measuring technique. (BH)

- Petrie, A. & C. Sabin. (2009) Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell.

covariate (1) a covariate is a variable used to assist in determining the value of the main variable(s) under study. (AW)

http://mayoresearch.mayo.edu/biostat/upload/80.pdf

Cox models (1) In health care a Cox model is a statistical technique for exploring the relationship between the survival of a patient and explanatory variables. In addition, it can give us an estimate of the treatment effect on survival after adjustment for other explanatory variables and therefore allows us to estimate prognostic risk(s) to the individual. (AW)

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cross tabulation (1) - taking two variables and tabulating the results of one variable against the other variable. A cross-tabulation gives you a basic picture of how two variables inter-relate. What we normally do is to calculate the Chi-squared statistic to see if this pattern has any substantial relevance. (BH)

(http://www.csse.monash.edu.au/~smarkham/resources/crosstab.htm)

imputation methods (1) - procedures for determining and assigning replacement values for missing, invalid or inconsistent data that have failed edits. This is done by changing some of the responses or assigning values when they are missing on the record being edited to ensure that estimates are of high quality and that a plausible, internally consistent record is created. (BH)

(http://stats.oecd.org/glossary/detail.asp?ID=3462)

Hazard Ratio (1) Hazard ratios have also been used to describe the outcome of therapeutic trials where the question is to what extent treatment can shorten the duration of the illness. However, the hazard ratio, a type of relative risk, does not always accurately portray the degree of abbreviation of the illness that occurred. In these circumstances, time-based parameters available from the time-to-event curve, such as the ratio of the median times of the placebo and drug groups, should be used to describe the magnitude of the benefit to the patient. The difference between hazard-based and time-based measures is analogous to the odds of winning a race and the margin of victory. The hazard ratio is the odds of a patient's healing faster under treatment but does not convey any information about how much faster this event may occur. HR = odds = $P/(1 - P)$; $P = HR/(1 + HR)$. And so, in this example, $P = 1.9/2.9 = 0.67$ (JB)

Spruance, et. al. (2004). *Hazard Ratio in Clinical Trials.*
Antimicrobial Agents and Chemotherapy, August 2004, p. 2787-2792, Vol. 48, No. 8

Kaplan-Meier predicted (estimated) median time (1) Kaplan-Meier analysis is used to analyze how a given population evolves with time. This technique is mostly applied to survival data and product quality data. There are three main reasons why a population of individuals or products may evolve: some individuals die (products fail), some other go out of the surveyed population because they get healed (repaired) or because their trace is lost (individuals move from location, the study is terminated, among other reasons). The first type of data is usually called "failure data", or "event data", while the second is called "censored data".

The Kaplan-Meier analysis allows you to compare populations, through their survival curves. For example, it can be of interest to compare the survival times of two samples of the same product produced in two different locations. Tests can be performed to check if the survival curves have arisen from identical survival functions. These results can later be used to model the survival curves and to predict probabilities of failure. (JB)

Reference

least-squares regression (2) *is a method for fitting a type of mathematical model. A regression model can have linear or non-linear independent variables. The dependent variable is numeric (logistic regression is used when the dependent variable is categorical). Least-squares refers to the mathematical method used to estimate the model coefficients. The coefficients are chosen to be those that minimize the squared errors from the observations to the model, hence least-squares. (JEO)*

log-normal regression model (1) - a form of generalized linear model used to relate one or more explanatory variables to the logit of the expected proportion of individuals with a particular outcome when the response is binary (BH)

- Petrie, A. & C. Sabin. (2009) Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: pg 164.

logistic regression (4) logistic regression is an approach to prediction when the variable to be measured is one of two types of variables. It can be binary in nature or has two categories, such as male/female, yes/no, alive/dead, on/of. Conversely, the variable can be continuous in nature, like 1-10 or 0.1-.05, representing a probability range. (AW)

multivariate analysis (2) - two or more outcomes of interest (response variables) are investigated simultaneously, e.g. multivariate ANOVA, cluster analysis, factor analysis. (BH)

- Petrie, A. & C. Sabin. () Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: pg 168.

multivariate risk scores (1) - graded measures of the likelihood that an individual will experience an event. Also called the prognostic score or prognostic index. (BH)

- Petrie, A. & C. Sabin. (2009) Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: pg 170.

Nonprobabiliy sampling. Any technique in which samples are selected in some way not suggested by probability theory. Examples include reliance on available subjects as well as purposive (judgmental), snowball, and quota sampling (Babbie, Earl The Basics of Social Research 3rd. ed p.188) (AE)

power calculations (2) - calculations to determine the probability of rejecting the null hypothesis when it is false. (BH)

- Petrie, A. & C. Sabin. (2009) Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: pg 169.

primary and secondary endpoints: determining which outcome most accurately reflects the desired treatment effect relies on the determination of endpoints. Two main points exist which are primary and secondary. The former relates to treatment efficacy, whereas the latter relates to treatment toxicity. (AW)

Petrie, A. & C. Sabin. (2009) Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: Chapter 14 page 40

propensity score (1) Propensity scoring is an alternative method to estimate the effect of receiving treatment when random assignment of treatments to subjects is not feasible. For example in observational studies, investigators have no control over the treatment assignment and therefore large differences may result due to covariates, which may lead to further biases in experimental application. The propensity scoring can be used to balance these biases.(AW)

D'Agostino Rb Jr. *Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group.* Department of Public Health Sciences, Wake Forest University School of Medicine, Winston-Salem Statistics in Medicine 1998 Oct 15;17(19):2265-81

reliability testing (1)- Within social research, tests conducted to establish reliability. Two examples of such tests are the Test-Retest Method (with the expectation that your results will remain the same), and the Split-Method, which randomly splits into two batches of measuring classifications. (JD) Babbie, p. 158-159

sequential trials: may be used occasionally when the time interval between a treatment and an outcome is expected to be short. These trials consists of a series of interim analyses, at each of which the trial might be stopped and a conclusion drawn. (AW) Petrie, A. & C. Sabin. Medical Statistics at a Glance. Hoboken, NJ: Wiley-Blackwell: Chp 14 page 42

Sociometric survey (1) - a quantitative survey used to measure of relationships within a group of people (BH)

- http://www.thefreedictionary.com/sociometric

t-tests (1) a test statistic used for testing hypotheses about statistical parameters such as the mean and regression coefficients (JEO)

therapeutic intervention scoring system (1) A Therapeutic Intervention Scoring System is used to allow quantitative comparison of patient care and research experiences of different intensive care units. Types of interventions are scored on a scale of intensity of use. The points acquired per patient per 24 hours are summated by an experienced observer. TISS has been used to: 1) determine appropriate utilization of intensive care facilities 2) provide information on nurse staffing ratios for various patient care areas; 3) quantitatively validate a clinical classification of critically ill patients into four categories 4) analyze cost of intensive care relative to the extent of care offered. See **PowerPoint**? file in Wiki Documents folder. (AW)