Stat 150 – Day 15
Studies and Conclusions

Example 1: Elvis
Elvis Presley is reported to have died in his Graceland mansion on August 16, 1977. On the twelfth anniversary of this event, a Dallas record company sponsored a national call-in survey. Listeners of over 1000 radio stations were asked to call a 1-900 number (at a charge of $2.50) to voice an opinion concerning whether or not Elvis was really dead. It turned out that 56% of the callers felt that Elvis was alive. Suppose this record company was interested in the opinions of all adult Americans on this issue.

> The ***population*** in a study refers to the *entire* group of people or objects about which information is desired. A ***sample*** is a (typically small) *part* of the population from which data are gathered, in an effort to learn about the population. If the sample is selected carefully, so that it is *representative* of the population, we gain very useful information about the population. The number of ***observational units*** studied in a sample is the ***sample size***.

(a) Identify the population and sample in this study.

population: sample:

(b) Do you think that 56% is an accurate reflection of beliefs of all Americans on this issue? If not, identify the primary flaw in the sampling method (selecting the sample from the population).

> A ***parameter*** is a number that describes a ***population*** (e.g., proportion of all Americans who believe Elvis is alive), while a ***statistic*** is a number that describes a ***sample*** (e.g., observed 56%).

Example 2: Courtroom Cameras
An article appearing in the October 4, 1994 issue of *The Harrisburg Evening-News* reported that Judge Lance Ito (who was trying the O.J. Simpson murder case) had received 812 letters from around the country on the subject of whether to ban cameras from the courtroom. Of these 812 letters, 800 expressed the opinion that cameras should be banned.

(a) What proportion of this sample supports a ban on cameras in the courtroom? Is this number a parameter or a statistic?

(b) Do you think that this sample represents the population of all American adults? If not, identify the primary flaw in the sampling method.

In both of these examples, the goal was to learn something about a very large population (e.g., all American adults, all American registered voters) by studying a sample. However, both used a very poor sampling method.. In neither case was the sample representative of the population, so one could not accurately infer anything about the population of interest from the sample results.

A sampling method is said to be ***biased*** if it tends *systematically* to overrepresent certain segments of the population and to systematically underrepresent others.

So, how can we avoid bias and ensure that the sample is likely to be representative of the population? By giving every member of the population an equal chance of being selected for the sample, which is called **(simple) random sampling**. Unfortunately, genuine random sampling, in which every member of the population has the same chance of being selected, is very difficult to implement in practice.

Example 3: Candy Cigarettes
In a study published in a 2007 issue of the journal *Preventive Medicine*, researchers found that smokers were significantly more likely to have used candy cigarettes as children than non-smokers were.

The variable whose effect one wants to study is called the ***explanatory variable***. The variable that one suspects is affected by the other is known as the ***response variable***.

(a) Identify the observational units in this study, as well as the explanatory and response variables. Classify each variable as categorical (also binary?) or quantitative.

Observational units:

Explanatory: Type:

Response: Type:

(b) Is it reasonable to conclude that using candy cigarettes as children *caused* a greater likelihood for becoming a smoker as an adult? Or can you think of an alternative explanation for why those who used candy cigarettes as children are more likely to smoke as adults? In other words, can you think of other ways in which the two groups (those who used candy cigarettes as children and those who did not) might have systematically differed, in a way that is relevant to whether or not they became smokers as adults?

In answering (b), you have identified a ***confounding variable***. A confounding variable is one whose potential effects on the response variable are indistinguishable from those of the response variable. ***Observational studies***, where the researcher passively observes and records information on observational units, without imposing the explanatory variable on the subjects, are always at risk for confounding variables Consequently, while an observational study may establish an *association* between the explanatory and response variables, you cannot draw a cause-and-effect conclusion between the explanatory and response variables.

Example 4: Heart Attacks

Studies conducted in New York City and Boston have noticed that more heart attacks occur in December and January than in all other months. Some people have tried to conclude that holiday stress and overindulgence causes the increased risk of heart attack.

(a) Identify a confounding variable whose effect on heart attack rate might be confounded with that of the month variable, providing an alternative explanation for the increased risk of heart attack in December and January.

(b) A follow-up study in Los Angeles revealed a similar finding: more heart attacks in December and January. Identify a potential confounding variable in the Boston and New York City studies that is eliminated from consideration in the Los Angeles study.

(c) Identify another confounding variable that still pertains to the Los Angeles study. [*Hint*: Think of one that would be eliminated by conducting the study in the southern hemisphere.]

So, how can we ever legitimately draw cause-and-effect conclusions? By assigning subjects to treatment (explanatory variable) groups in such a way that the groups are likely to be as similar as possible on all characteristics *except* the explanatory variable. Then if we see a significant difference in the response variable between the groups, we can conclude that the explanatory variable is *causing* the difference in the response.

An ***experiment*** is a study in which the experimenter *actively imposes* the ***treatment*** (explanatory variable group) on the subjects. Ideally, the groups of subjects are identical in all respects other than the explanatory variable, so the researcher can then see the direct effect of this explanatory variable on the response. ***Random assignment*** is the preferred method of assigning subjects to *treatments* (explanatory variable groups) in an experiment. This gives each subject an equal chance of being assigned to any of the treatment groups.

Example 5: Dolphin Therapy

Swimming with dolphins can certainly be fun, but is it also therapeutic for patients suffering from clinical depression? To investigate this possibility, researchers recruited 30 subjects aged 18-65 with a clinical diagnosis of mild to moderate depression. Subjects were required to discontinue use of any antidepressant drugs or psychotherapy four weeks prior to the experiment, and throughout the experiment. These 30 subjects went to an island off the coast of Honduras, where they were randomly assigned to one of two treatment groups. Both groups engaged in the same amount of swimming and snorkeling each day, but one group (the animal care program) did so in the presence of bottlenose dolphins and the other group (outdoor nature program) did not. At the end of two weeks, each subjects' level of depression was evaluated, as it had been at the beginning of the study (Antonioli and Reveley, 2005).

Results of this study are summarized in the table below:

	Animal care program (dolphin therapy)	Outdoor nature program (control group)	Total
Showed substantial improvement	10	3	13
Did not show substantial improvement	5	12	17
Total	15	15	30

(a) Identify the observational units, explanatory variable, and response variable.

Observational units:

Explanatory: Type:

Response: Type:

(b) Is this an observational study or an experiment? Explain how you know.

(c) Why did the researchers include a comparison group in this study? Why didn't they just see how many patients showed substantial improvement when given the dolphin therapy?

(d) Why did the researchers randomly assign subjects to treatment groups, rather than allowing them to choose for themselves whether to swim with dolphins or not? What advantages does randomization provide?

(e) Why did the researchers not tell subjects about the other group?

(f) Why did the researchers not provide information about who was in which group to the medical professionals who evaluated the patients?

Three principles of well-designed experiments are **comparison**, **randomization**, and **blindness**, preferably **double-blindness**.

(g) Calculate the proportions who improved substantially in each group. Also construct a relevant graph to display these data.

(h) The difference between the improvement rates in the two gropups can be shown to be statistically significant, meaning that such an extreme difference would be very unlikely to occur by random assignment alone if there were no effect of the dolphin therapy. Is it legitimate to conclude that dolphin therapy caused the greater likelihood of improvement for these subjects? Explain why or why not.

(i) Were the subjects in this study randomly selected from the population of all people who suffer from mild to moderate depression? If not, how do you think they were they selected? What is the implication of this for how broadly the findings of this study can be generalized? Explain.

Taken as a whole, these examples reveal that there are two crucial questions to ask of any statistical investigation:

- To what population can we reasonably generalize the results of this study?
- Can we reasonably draw a cause-and-effect connection between the explanatory variable and the response variable?

Ideal studies make use of two kinds of randomness:

- Random *sampling* from the population allows for generalizing results from the sample to the larger population.
- Random *assignment* to treatment groups permits cause-and-effect conclusions to be drawn.

Many studies make use of only one of these, so conclusions are limited. Other studies make use of neither! It is crucial to consider the type of study before drawing conclusions.