STATISTICS 8

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Course Goals

- Help you understand and appreciate how statistics affects your daily life.
- Teach you tools for understanding statistics and statistical studies you encounter in biological sciences and other courses.
- Teach you how to critically read news stories based on statistical studies.
- Teach you some basic methods for conducting and analyzing statistical studies.

Announcements

- Today we will go over the syllabus, then cover part of Chapter 1 (read the rest on your own) and Sections 2.1 to 2.3.
- Clicker questions for credit start on Mon. If possible, purchase and register your clicker by then. (There is a link to the registration site on our course website.)

Chapter 1

Statistics Success Stories and Cautionary Tales

1.1 What is Statistics?

Statistics is a collection of procedures and principles for gathering data and analyzing information in order to help people make decisions when faced with uncertainty.

1.2 Seven Statistical Stories With Morals

- **Case Study 1.1: Who Are Those Speedy Drivers?**
- **Case Study 1.2: Safety in the Skies**
- **Case Study 1.3: Did Anyone Ask Whom You've Been Dating?**
- **Case Study 1.4: Who Are Those Angry Women?**
- **Case Study 1.5: Does Prayer Lower Blood Pressure?**
- **Case Study 1.6: Does Aspirin Reduce Heart Attack Rates?**
- **Case Study 1.7: Does the Internet Increase Loneliness and Depression?**

Case Study 1.1 *Who Are Those Speedy Drivers?*

Question: What's the fastest you have ever driven a car? _____ mph.

Data: 87 male and 102 female students from large statistics class at University.

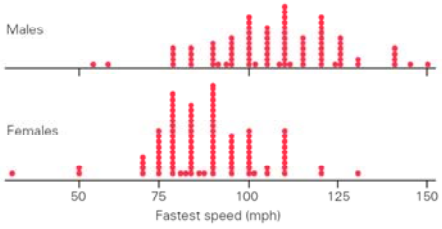
Males: 110 109 90 140 105 150 120 110 110 90 115 95 145 140 110 105 85 95 100 115 124 95 100 125 140 85 120 115 105 125 102 85 120 110 120 115 94 125 80 85 140 120 92 130 125 110 90 110 110 95 95 110 105 80 100 110 130 105 105 120 90 100 105 100 120 100 100 80 100 120 105 60 125 120 100 115 95 110 101 80 112 120 110 115 125 55 90

Females: 80 75 83 80 100 100 90 75 95 85 90 85 90 90 120 85 100 120 75 85 80 70 85 110 85 75 105 95 75 70 90 70 82 85 100 90 75 90 110 80 80 110 110 95 75 130 95 110 110 80 90 105 90 110 75 100 90 110 85 90 80 80 85 50 80 100 80 80 80 95 100 90 100 95 80 80 50 88 90 90 85 70 90 30 85 85 87 85 90 85 75 90 102 80 100 95 110 80 95 90 80 90

Which gender has driven faster? How to summarize data?

Case Study 1.1 *Who Are Those Speedy Drivers?*

Dotplot: each dot represents the response of an individual student.



Case Study 1.1 *Who Are Those Speedy Drivers?*

Five-number summary: the lowest value, the cutoff points for ¼ , ½, and ¾ of the data, and the highest value.

	Males (87 Students)		Females (102 Students)	
Median	110		89	
Quartiles	95	120	80	95
Extremes	55	150	30	130

Note: ¾ of men have driven 95 mph or more, only ¼ of women have done so.

Moral: *Simple summaries of data can tell an interesting story and are easier to digest than long lists.*

READ ON YOUR OWN:

Case Study 1.2 ***Safety in the Skies?***

Case Study 1.3 ***Did Anyone Ask Whom You've Been Dating?***

Case Study 1.4 ***Who Are Those Angry Women?***

Case Study 1.7 ***Does the Internet Increase Loneliness and Depression?***

Case Study 1.5 *Does Prayer Lower Blood Pressure?*

"Attending religious services lowers blood pressure more than tuning into religious TV or radio, a new study says"

USA Today **headline read:**
"Prayer can lower blood pressure." (Davis, 1998)

Based on ***observational study***, followed 2391 people 6 years.

"People who attended a religious service once a week and prayed or studied the Bible once a day were 40% less likely to have high blood pressure than those who don't go to church every week and prayed and studied the Bible less."

Researchers ***did observe a relationship***, but it's a **mistake to conclude** prayer actually ***causes*** lower blood pressure.

Case Study 1.5 *Does Prayer Lower Blood Pressure?*

In observational studies, **groups can differ** by important ways that may contribute to the observed relationship.

People who attended church regularly may have …

- •been less likely to smoke or drink alcohol;
- •had a better social network;
- •been somewhat healthier and able to go to church.

These other factors are possible ***confounding variables***.

Moral: *Cause-and-effect conclusions cannot generally be made based on an observational study.*

Case Study 1.6 *Does Aspirin Reduce Heart Attack Rates?*

Physician's Health Study (1988)

5-year ***randomized experiment*** …

- 22,071 male physicians of age 40 - 84;
- ***randomly assigned*** to one of two ***treatment*** groups;
- Group 1 = aspirin every other day; Group 2 = ***placebo***;
- Physicians ***blinded*** as to which group they were in.

Case Study 1.6 *Does Aspirin Reduce Heart Attack Rates?*

TABLE 1.1 The Effect of Aspirin on Heart Attacks

Treatment	Heart Attacks	Doctors in Group	Attacks Per 1000 Doctors
Aspirin	104	11,037	9.42
Placebo	189	11,034	17.13

Aspirin group: 9.42 heart attacks per 1000 participants
Placebo group: 17.13 heart attacks per 1000 participants

Randomization => other important factors (age, diet, etc) should have been similar for both groups. Only important difference should be whether they took aspirin or placebo.

Moral: *Unlike with observational studies, cause-and-effect conclusions can generally be made on the basis of randomized experiments.*

1.3 The Common Elements in the Seven Stories

In every story, ***data are used to make a judgment about a situation.***

This is what ***statistics*** is all about.

The Discovery of Knowledge

- *Asking the right question(s).*
- *Collecting useful data*, which includes deciding how much is needed.
- *Summarizing and analyzing data*, with the goal of answering the questions.
- *Making decisions and generalizations* based on the observed data.
- *Turning the data and subsequent decisions into new knowledge.*

Chapter 2

Turning Data Into Information

2.1 Raw Data

- **Raw data** are numbers and category labels that have been collected (on individuals) but have not yet been processed in any way.
- **Observational units** are the individuals for which raw data are measured. These are usually people, but could be plants, forests, dogs, cities, schools, etc.
- When measurements are taken from a subset of individuals in a population, they represent **sample data.**
- When all individuals in a population are measured, the measurements represent **population data.**
- **Descriptive statistics** are summaries of the raw data for all the individuals in a population or a sample.

2.2 Types of Variables

- Raw data from **categorical variables** are *group or category names* measured on individuals, that don't necessarily have a logical ordering.
  Examples: Smoker (yes/no), Live on or off campus, Political party (democrat, republican, etc.)
- Categorical variables for which the categories have a logical ordering are called **ordinal variables**.
  Examples: Class level (freshman, sophomore, etc.), Glove size (S,M,L)
- Raw data from **quantitative variables** consist of *numerical values* taken on each individual.
  Examples: GPA, Weight, Age.

Asking the right questions for summarizing raw data, based on type

One Categorical Variable

Question 1: How many and what percentage of individuals fall into each category?

Example: What percentage of drivers talk on cell phones often, what percentage do so sometimes, and what percentage never do so?

Question 2: Are individuals equally divided across categories, or do the percentages across categories follow some other interesting pattern?

Example: When individuals are asked to "randomly" choose a number from 1 to 10, are all numbers equally likely to be chosen?

Asking the Right Questions

Two Categorical Variables

Question 1: Is there a relationship between the two variables, so that the category into which individuals fall for one variable seems to depend on which category they are in for the other variable?

Examples: Does the proportion of drivers who talk on cell phones differ across age groups? Are males and females equally likely to be stopped for speeding?

Question 2: Do some combinations of categories stand out because they provide information that is not found by examining the categories separately?

Example: The relationship between smoking and lung cancer was detected, in part, because someone noticed that the *combination* of being a nonsmoker and having lung cancer is unusual.

Explanatory and Response Variables

•When asking questions are about the **relationship** between *two variables,* it is useful to identify one variable as the **explanatory variable** and the other variable as the **response variable.**

•In general, the *value of the **explanatory** variable* for an individual is thought to **partially explain** the *value of the response variable* for that individual. Note that this does not mean it *causes* changes in the value of the response variable.

Examples:

- Explanatory: aspirin/placebo, Response: heart attack or not
- Explanatory: prayer (yes/no), Response: blood pressure

2.3 Summarizing One or Two Categorical Variables

Numerical Summaries:

- One variable: Count how many fall into each category, and/or calculate the percent in each category.
- Two variables: create a "two-way table."
  - Categories of the *explanatory* variable define the *rows,* response variable defines *columns*.
  - *Compute row percentages* and compare.

Example 2.2 *Lighting the Way to Nearsightedness*

Survey of ***n* = 479** children.
Those who slept with nightlight or in fully lit room before age 2 had higher incidence of nearsightedness (myopia) later in childhood.

TABLE 2.3 Nighttime Lighting in Infancy and Eyesight

Slept with:	No Myopia	Myopia	High Myopia	Total
Darkness	155 (90%)	15 (9%)	2 (1%)	172
Nightlight	153 (66%)	72 (31%)	7 (3%)	232
Full Light	34 (45%)	36 (48%)	5 (7%)	75
Total	342 (71%)	123 (26%)	14 (3%)	479

Note: Study *does not prove* sleeping with light actually *caused* myopia in more children.

Graphical (Visual) Summaries for Categorical Variables

- **Pie Charts**: useful for summarizing a single categorical variable if not too many categories.
- **Bar Graphs**: useful for summarizing one or two categorical variables and particularly useful for making comparisons when there are two categorical variables.

Example 2.3 *Humans Are Not Good Randomizers*

Survey of ***n* = 190** college students.
"Randomly pick a number between 1 and 10."

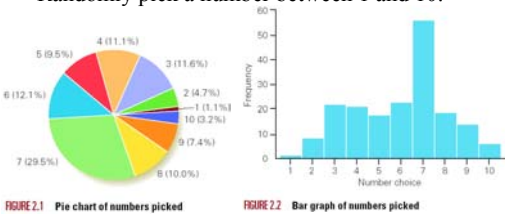


FIGURE 2.1 Pie chart of numbers picked

FIGURE 2.2 Bar graph of numbers picked

Results: Most chose 7, very few chose 1 or 10.

Example 2.4 *Revisiting Nightlights and Nearsightedness*

Survey of ***n* = 479** children.

Response: Degree of Myopia

Explanatory: Amount of Sleeptime Lighting

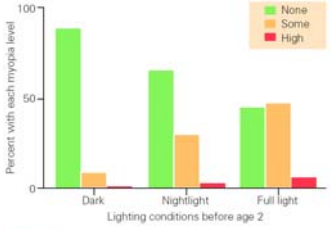


FIGURE 2.3 Bar chart for myopia and nighttime lighting in infancy

Summary of Key Points

- Recognize an observational study (no cause/effect) vs a randomized experiment.
  Exercise 1.20: *Vegetarians had lower heart disease and cancer death rates than non-vegetarians.*
  Exercise 1.23: *Volunteers randomly assigned to nicotine patch or placebo, 46% vs 20% quit.*
- Explanatory variable/ response variable
  For the two examples above?
- Categorical data/ quantitative data
  For the two examples above?

Summarizing one categorical variable:

- Pie Charts
- Bar Graphs

Summarizing two categorical variables:

- Two-way table (explanatory variable as rows)
- Row percents (or column percents), use for comparisons
- Bar graphs (explanatory variable categories as separate sets of bars)

Homework; Sections to Read

- Read Chapter 1
- Read Chapter 2, sections 2.1 to 2.3 (up to page 24)
- Exercises, **due Friday, October 1**:
  1.10 (pg.10)
  2.9, 2.27 (pgs. 58, 60)