# Antiracist teaching in an introductory biostatistics course

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# Outline

- Course Structure
- Week A: ANOVA
- Week B: Meaningful differences
- Feedback

# Weekly Course Structure

**Instruction:**

First class of the week: Lecture

Between classes: Software lab

**Practice:**

Second class of the week: Problem set work session

Next 48 hours: Collaborative answer key

**Assessment:**

Either end of week quiz or homework

Mid- and end-of-semester: comprehensive analysis

# Week A: ANOVA and Pairwise Comparisons

# Lecture: introducing dataset

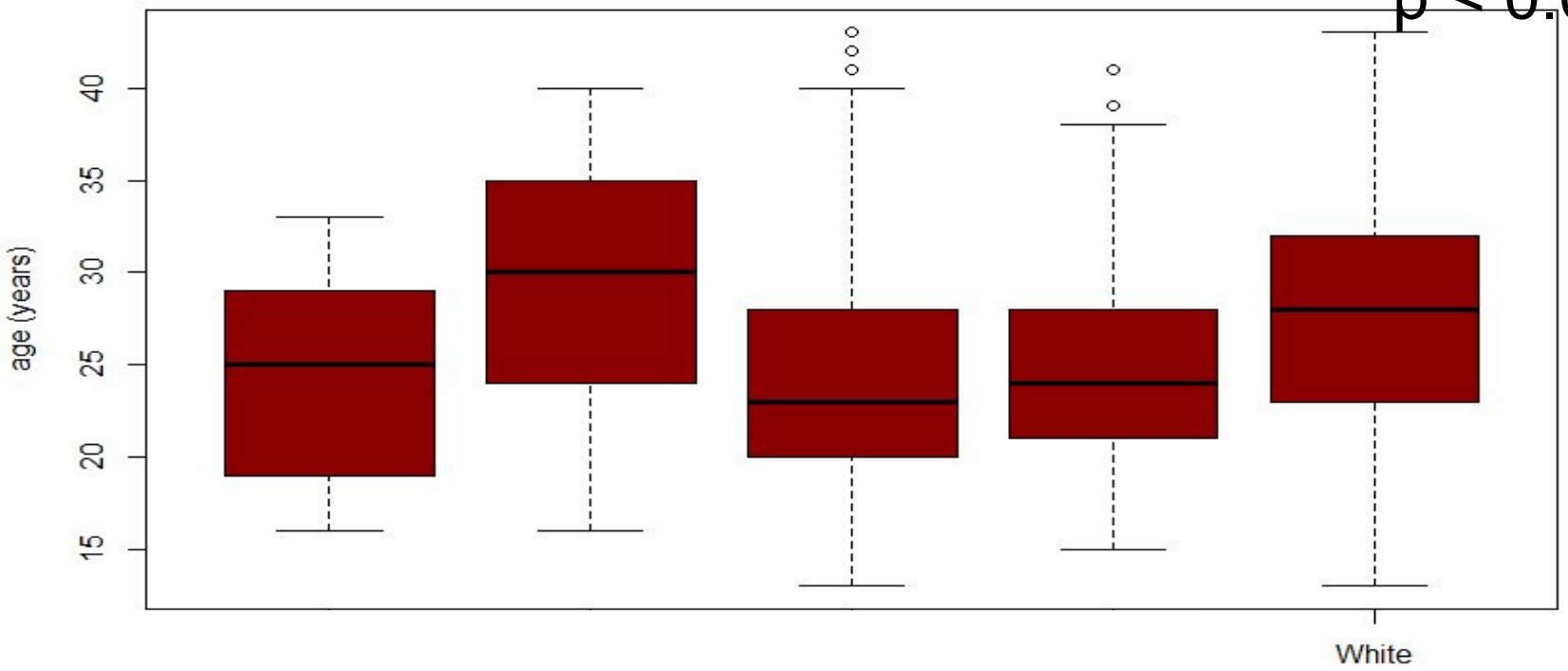
The North Carolina State Center for Health and Environmental Statistics compiles data on every birth in North Carolina.

- a random sample of 1409 births in 2001
- Race/ethnicity of mother (American Indian, Asian or Pacific Islander, Black, Hispanic, White)
- Mother's age at birth of child
- Is there any difference in average birthweight for the different races/ethnicities?

# Lecture: exploratory data analysis

F = 26.7

p < 0.0001




American Indian | Asian Pacific Isl | Black | Hispanic | White

# Lecture: multiple comparisons

| Race/Ethnicity | Race/Ethnicity | Confidence interval |
|---|---|---|
| **AIAN** | **Asian/PI** | **(-9.96 y, -0.58 y)** |
| AIAN | Black | (-4.05 y, 3.02 y) |
| AIAN | Hispanic | (-4.31 y, 3.01 y) |
| **AIAN** | **White** | **(-7.32 y, -0.38 y)** |
| **Asian/PI** | **Black** | **(1.42 y, 8.08 y)** |
| **Asian/PI** | **Hispanic** | **(1.16 y, 8.08 y)** |
| Asian/PI | White | (-1.84 y, 4.67 y) |
| Black | Hispanic | (-1.71 y, 1.44 y) |
| **Black** | **White** | **(-4.38 y, -2.29 y)** |
| **Hispanic** | **White** | **(-4.61 y, -1.80 y)** |

# Problem set: continue exploring birth outcomes

Problem sets are 30 - 40 questions that guide students through an analysis.

1. Using your software of choice, create a graphical display for the `MomAge` comparing the four race/ethnicity categories used by North Carolina (`NCRace`). Share your code and output.
2. Using your software of choice, calculate summary statistics for the `MomAge` variable by the race/ethnicity variable, `NCRace`. Fill in the values in the table below. Share your code and output.
3. Based on the graphs, summary statistics, and sample size, are all of the conditions met for carrying out an Analysis of Variance (ANOVA) hypothesis test? Explain your reasoning.

Students can work collaboratively to answer the questions during class with instructor assistance.

# Problem set: North Carolina statistics

North Carolina State Center for Health Statistics Uses 3 race categories and 1 Ethnicity category.

**Risk Factors and Characteristics for 2001 North Carolina Resident Live Births**

**All Mothers**

| | TOTAL | | WHITE | | BLACK | | OTHER RACES | | HISPANIC (ALL RACES) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | # | % | # | % | # | % |
| **Total** | **118,112** | **100** | **85,204** | **72.1** | **28,365** | **24.0** | **4,543** | **3.8** | **14,522** | **12.3** |
| Birthweight | | | | | | | | | | |
| <500 grams | 291 | 0.2 | 127 | 0.1 | 152 | 0.5 | 12 | 0.3 | 18 | 0.1 |
| 500 -1,499 grams | 2002 | 1.7 | 1087 | 1.3 | 842 | 3.0 | 73 | 1.6 | 141 | 1.0 |
| 1,500 - 2,499 grams | 8286 | 7.0 | 5040 | 5.9 | 2920 | 10.3 | 326 | 7.2 | 735 | 5.1 |
| 2,500+ grams | 107,492 | 91.0 | 78,921 | 92.6 | 24,440 | 86.2 | 4,131 | 90.9 | 13,623 | 93.8 |
| Unknown | 41 | 0.0 | 29 | 0.0 | 11 | 0.0 | 1 | 0.0 | 5 | 0.0 |

# Problem set analyses

1. Re-analyze lecture data using NC categories
   - Compare these results to those found in lecture. What are the dangers of combining race/ethnicity categories into one "Other" category?
2. Analyze birthweights using the 4 NC categories
   - Refer back to the first table from the North Carolina State Center for Health statistics (on page 1 of this activity). Do your results support or contradict the information in the table?
3. Analyze birth weight using 5 race/ethnicity categories from lecture
   - Examine the results using North Carolina's four race/ethnicity categories (that grouped two different populations, American Indians and people of Asian or Pacific Islander heritage, into one "Other" category) to the five race/ethnicity category analysis done in questions 24 – 31. What results are similar? What results differ?

# Collaborative Answer Key

Students are required to contribute once to the answer key in a 48 hour period.

- Answer a question
- Respond to someone else's answer

Credit given for participation, not "being correct".

Instructors there to encourage and guide, but not give answers.  Unanswered questions remain unanswered.

Bonus point given for engaging more than one day.

# Collaborative Answer Key Example

1. Based on the Tukey's HSD intervals, which race/ethnicity(s) has a significantly higher average birth weight than the others?

Student 1 Among all of the race groups, the Hispanic group has a significantly higher average birth weight than the others because the Tukey HSD test yields the maximum positive difference for this group.

Jen Czachura: The Hispanic women do have a higher average birth weight than all the other groups, but is it **significantly** higher than all the groups?

Student 2: I also said that Hispanic women had a significantly higher average birth weight - how would we distinguish between higher & *significantly* higher in SAS?

Student 3: I think we just say higher when we subtract one group from the other and get a positive number and we say significantly higher if the confidence interval did not include zero and p value is less 0.05.

Student 4: Based on the data, it looks like Hispanic mothers had significantly higher birth weights than Black mothers, and white mothers also had significantly higher birth weight than Black mothers.

# Week B: Meaningful Differences

# Lecture: Practical vs Statistical Significance

Practical significance:

- Detect meaningful difference
- Increase lung capacity by 10% or more

Statistical significance:

- The chance is small of getting our sample(s) when the null is true.
- We may be able to get a very small p-value even when the lung capacity increases by < 10%

Power: balance between practical and statistical significance!

# Lecture: Practical Significance and power

3 options when effect size > MoE:

- Population parameter is practically significant from the null value: |parameter – null| > effect size
  - **Reject the null**
- Population parameter is **not** practically significant from the null value: |parameter – null| < effect size
  - CI > effect size: **Fail to reject the null**
- Population parameter is **the same as** the null value:
  - CI < effect size: **Accept the null**

# Problem Set Analyses

1. Re-run ANOVA and pairwise comparisons to look at differences in birthweight by race
   - Which groups have a mean difference that is larger than the effect size (200g)? Smaller than the effect size?

2. Test for statistically significant differences
   - For those intervals that were not statistically significant, did any of those intervals fall within the **equivalence threshold**; i.e. the interval was entirely within the interval: null ± effect size (-200 g, 200 g)?

3. Investigate possible reasons for differences or lack of differences
   - What could be the reason for the results? (Hint: think about Type I error, Type II error, and Power.)

# Problem Set: Birthweight Comparisons

| | diff | lwr | upr | p adj |
|---|---|---|---|---|
| AsianPacificIsl-AmericanIndian | 110.049545 | -385.66467 | 605.7638 | 0.9741169 |
| Black-AmericanIndian | -136.857955 | -510.46752 | 236.7516 | 0.8551888 |
| Hispanic-AmericanIndian | 91.408957 | -295.24793 | 478.0658 | 0.9674524 |
| White-AmericanIndian | 81.507342 | -284.49550 | 447.5102 | 0.9738192 |
| Black-AsianPacificIsl | -246.907500 | -598.90047 | 105.0855 | 0.3092246 |
| Hispanic-AsianPacificIsl | -18.640588 | -384.45269 | 347.1715 | 0.9999156 |
| White-AsianPacificIsl | -28.542203 | -372.45065 | 315.3662 | 0.9994151 |
| Hispanic-Black | 228.266912 | 61.92383 | 394.6100 | 0.0017344 |
| White-Black | 218.365297 | 108.25377 | 328.4768 | 0.0000007 |
| White-Hispanic | -9.901615 | -158.37380 | 138.5706 | 0.9997541 |

# Collaborative Answer Key Example

1. What could be the reason for the results seen in the previous question? (Hint: think about Type I error, Type II error, and Power.)

Student 1: This error could have occurred because of low power to detect a difference; we may have low power because of a small sample size. The number of women of Asian or Pacific Islander ancestry sampled appears to be just 25.

Jen Czachura: Good job! Does anyone have the sample sizes for each of the groups here? That could further support Mariah's conclusion. Does anyone see a relationship between the sample sizes and the confidence intervals?

Student 2: table(NCbirths$MomRace) → R code.

| AmericanIndian | AsianPacificIsl | Black | Hispanic | White |
|---|---|---|---|---|
| 22 | 25 | 324 | 153 | 885 |

I think because MoE (conf.level*SE) and SE is based on sample size, and those values are used to calculate the confidence interval.

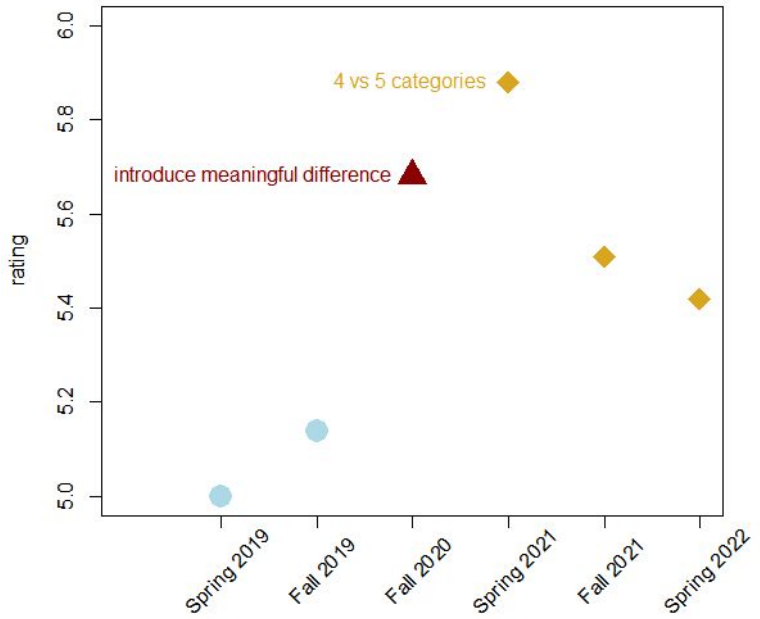
Jen Czachura: Good! With a smaller sample size, the SE (SD/sqrt(n)) is larger, so our confidence intervals will be wider. With a wider CI, we are less likely to have a CI that is within the effect size.

# Feedback

As an American Indian student, I appreciate you including American Indians in our data sets…. Your work and effort around inclusivity and equity does not go unnoticed! Thank you!!!!!

**Student Evaluations**

"The instructor facilitated learning activities (e.g. discussion, assignments, readings) that deepened my understanding of health inequalities."



# Acknowledgements

We would like to thank:

- our colleagues Drs. Laura Le and Ann Brearley for creating the collaborative answer key concept,
- Dr Linda Frizzell for challenging us to stop “othering” indigenous peoples,
- The University of Minnesota School of Public Health for emphasizing health as a human right, and
- Our students who challenge us to be more inclusive.

# Resources

Data set:

- R package: Stat2Data, dataset: NCbirths
- https://github.com/vincentarelbundock/Rdatasets/tree/master/csv/Stat2Data

North Carolina State Center for Health Statistics:

- https://schs.dph.ncdhhs.gov/schs/births/matched/2001/all.html

UMN SPH Strategic Plan for Anti Racism:

- https://www.sph.umn.edu/about/diversity-inclusion/strategy-planning/