### Assigned Readings

* [Statistical Thinking](https://zief0002.github.io/statistical-thinking/)
  + [Internal Validity Evidence and Random Assignment](https://zief0002.github.io/statistical-thinking/internal-validity-evidence-and-random-assignment.html)
  + [External Validity Evidence and Random Sampling](https://zief0002.github.io/statistical-thinking/external-validity-evidence-and-random-sampling.html)
  + [Validity Evidence and Inferences](https://zief0002.github.io/statistical-thinking/validity-evidence-and-inferences.html)

### Key Ideas

* Internal Validity Evidence
  + To establish a causal claim, all other possible explanations need to be ruled out.
  + To rule out other possible explanations, the control group and experimental group need to be identical. If two groups are the same in every way except the treatment they receive, then any differences must be because of the treatment.
  + It is impossible to make two groups exactly identical, but we can make them probabilistically equivalent by using random allocation.
  + With random allocation, we expect that the random allocation process on average will produce equal groups.
  + But more important, we can model and mimic the random allocation process and analyze the probabilistic equivalence.
  + Random assignment helps provide strong evidence of cause-and-effect inferences.
* External Validity Evidence
  + Generalization refers to using results from a sample to draw conclusions about the larger population of inference from which the sample was drawn.
  + However, inferences are inherently uncertain. How reasonable are our inferences? How confident can we be? The degree to which generalizations are accurate and meaningful is called external validity.
  + All sampling strategies produce sampling variation -- i.e., using the same strategy, each sample will give a slightly different result. The question is how different will it be? And will it provide us accurate results?
  + Two characteristics of sampling variability are bias and precision. Bias refers to whether or not a sampling strategy will on average produce a correct result. Precision refers to the consistency of the estimate the sampling strategy produces and how close each different sample estimate is to each other. The best sampling strategy is one with no bias and very high precision (i.e., low standard error).
  + Using random sampling is an unbiased sampling strategy.
  + But more important, we can model and mimic the random sampling process and analyze the sampling variability (i.e., precision, a.k.a. standard error).
  + Random sampling helps provide strong external validity evidence for generalizations of results from a sample to the population from which it was sampled.
* Validity Evidence and Inferences
  + Validity is the degree to which inferences and conclusions are meaningful and accurate. We can never 100% establish validity, but we provide evidence to support the validity of our inferences.
  + Internal validity evidence supports drawing cause-and-effect conclusions. A strong validity evidence for this type of conclusion is when a study uses random assignment. Without random assignment, it is very hard (and may be impossible) to validate drawing a cause-and-effect conclusion.
  + External validity evidence supports drawing generalizable conclusions (to the population of interest from which the sample was selected). A strong validity evidence for this type of conclusion is when a study uses random sampling. Without random sampling, it is very hard (and may be impossible) to validate generalizing results from a sample.
  + Not all studies seek to draw both cause-and-effect conclusions and generalize them. The validity evidence required depends on the study's goals.
  + When considering a problem pay attention to:
    - what is the population of interest?
    - how were participants sampled?
    - do the researchers want to generalize the results of their sample to the population of interest?
    - do the researchers have control/treatment groups?
      * if so, how were participants assigned to these groups?
    - what variables did the researchers measure?
      * what is the main response variable they are analyzing?
      * what explanatory variables do they think affect the response variable?
    - what statistical results are the researchers drawing?
    - are these conclusions supported by the appropriate validity evidence?
    - \*be sure to read through Study Design #1, #2, and #3 using this framework.