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# Natural Experiments & Observational Studies

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Michael Baiocchi, PhD

## Key features

- Randomized controlled experiments (RCTs) are the best way to generate data for reliable estimation of causal effects; this is true because RCTs control observed covariates so the comparison groups are comparable but also inject randomization so unobserved covariates cannot not systematically bias estimates.
- Natural experiments try to emulate RCTs by exercising control over observed covariates (e.g., through matching or inverse-probability weighting) and – *distinctly from other types of observational studies* – also identifying a source of haphazardness in the assignment process to treatment and control.

## Settings where natural experiments can be useful

- When running an RCT poses ethical concerns (e.g., estimating the effect of cigarette smoking on rates of cancer).
- When the costs of an RCT are prohibitive (e.g., what is the effect of insurance on health outcomes).
- When innovation is too fast (e.g., by the time the RCT produces results the field has moved on).
- When more evidence is needed before progressing to an RCT (see ORBIT model and NIH Stage Model).

## Advantages of natural experiments

- Can be faster and cheaper than RCTs because the observational data already exist and were generated passively.
- The logistics of obtaining the data are much lower than in RCTs. Smaller teams can produce the research.
- RCTs often must exclude certain people (e.g., too sick) whereas natural experiments do not (i.e., better generalizability).

## Disadvantages of natural experiments

- Designs can be challenging, inference can be complex, often requires collaboration with statistician or economist.
- Natural experiments are not definitive; there is always some doubt about the reliability of their conclusions. They should be viewed as good additions to a portfolio of research investigating a topic, rather than settling a debate.



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## Prior to meeting with a statistician

- Work through what randomized controlled trial you are attempting to emulate (see: Hernan and Robins 2016).
- Prepare a list of covariates you have in your data set. Come up with a list of covariates you are concerned are missing and therefore cannot control.
- Much of the discussion will focus on the source of randomness you are thinking of using for your natural experiment. Prepare to talk in detail about how this “randomness” works in practice. If you have seen other researchers use this type of natural experiment in the literature bring that along.

## References/Resources

- **[control and randomness]** Rosenbaum, P. R. (2005). Heterogeneity and causality: Unit heterogeneity and design sensitivity in observational studies. *The American Statistician*, 59 (2), 147-152.
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- **[emulating target trials]** Hernán, M. A., & Robins, J. M. (2016). Using big data to emulate a target trial when a randomized trial is not available. *American journal of epidemiology*, 183 (8), 758-764.
- **[discontinuity designs]** Imbens, G. W., & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of econometrics*, 142(2), 615-635.
- **[instrumental variables]** Baiocchi, M., Cheng, J., & Small, D. S. (2014). Instrumental variable methods for causal inference. *Statistics in medicine*, 33(13), 2297-2340.
- the unmatched count technique. *Organizational Research Methods*, 7(1), 101-114.

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