Causal Inference in Epidemiology

Douglas Ezra Morrison

Last modified: 2025-09-09: 23:40:09 (UTC)

Contents

Preface

This will be an online book about causal inference.

Here are some other resources for learning causal inference:

UC Davis courses

- EPI 205[1] "Principles of Epidemiology"
- EPI 206[2] "Epidemiologic Study Design"
- EPI/SPH 207[3] "Advanced Epidemiologic Methodology"
- EPI 225[4] "Advanced Topics in Epidemiology Methods"
- POL 285[5] "Statistics of Causal Inference in Political Science"
- MGB/MGP/MGT 454A[6] "Causal Inference and Statistical Experiments"
  - syllabus: https://webapps.aws.ucdavis.edu/public/documents/4861649/Syllabushttps://schedule.aws.ucdavis.edu/public/documents/5319910/Syllabus
- PSC 204B[7] "Causal Modeling of Correlational Data"
- PSC 205C[8] "Structural Equation Modeling"

Course search options:

- https://schedule.aws.ucdavis.edu/courseScheduling
- https://catalog.ucdavis.edu/course-search/
- https://catalog.ucdavis.edu/courses-subject-code/

Online Videos

- "Introduction to Causal Inference"[9] (slides here[10])
- Online Causal Inference Seminar series[11]

[1] https://catalog.ucdavis.edu/search/?q=EPI+205
[2] https://catalog.ucdavis.edu/search/?q=EPI+206
[3] https://catalog.ucdavis.edu/search/?q=EPI+207
[4] https://catalog.ucdavis.edu/search/?q=EPI+225
[5] https://catalog.ucdavis.edu/search/?q=POL+285
[6] https://catalog.ucdavis.edu/search/?q=MGB+454A
[7] https://catalog.ucdavis.edu/search/?q=PSC+204B
[8] https://catalog.ucdavis.edu/search/?q=PSC+205C
[9] https://ucdhs.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=43e9eb6f-3ed9-41ac-8ad9-ae22016572c8%20
[10] https://health.ucdavis.edu/media-resources/ctsc/documents/pdfs/causal-inference-intro-2022.pdf
[11] https://www.youtube.com/channel/UCiiOj5GSES6uw21kfXnxj3A/videos

UC Davis Datalab learning group

- https://datalab.ucdavis.edu/causal-inference/
  - Reading list[12]

Other links:

- https://cameron.econ.ucdavis.edu/causal/
- https://datalab-icmat.github.io/causal_reading_group.html
- Lab exercises by Ben Noble[13]: https://github.com/bennoble/causal-inference-2022

Books

- Judea Pearl (2016)
- Hernán and Robins (2020)

[12] https://docs.google.com/document/d/1K0QZFSjQIYnOTahpRK7Q83eaiIIFjfa-clSbj_ifgco/edit?tab=t.0#heading=h.farbmh6n76gq
[13] https://benjaminnoble.org/

1 Introduction to causal inference

Definition 1.1 (Exchangeability)**.** Subpopulations defined by exposure X are exchangeable with respect to a potential outcome $Y(x)$ if the distribution of $Y(x)$ does not depend on the observed exposure X:

$$Y(x) \perp\!\!\!\perp X$$

Theorem 1.1. *If subpopulations defined by values of exposure X are exchangeable with respect to potential outcome $Y(x)$, then the expected value of $Y(x)$ does not depend on the observed value of X:*

$$E[Y(x)|X = x'] = E[Y(x)|X = x]$$

Definition 1.2 (Conditional exchangeability)**.** Subpopulations defined by exposure X are exchangeable with respect to a potential outcome $Y(x)$ if the distribution of $Y(x)$ does not depend on the observed exposure X, conditional on covariate(s) Z:

$$Y(x) \perp\!\!\!\perp X|\tilde{Z}$$

Theorem 1.2. *If subpopulations defined by values of exposure X are conditionally exchangeable with respect to potential outcome $Y(x)$ given covariate $\tilde{Z}$, then the expected value of $Y(x)$ does not depend on the observed value of X:*

$$E\Big[Y(x)|X = x', \tilde{Z} = \tilde{z}\Big] = E\Big[Y(x)|X = x, \tilde{Z} = \tilde{z}\Big]$$

2 Difference in differences analyses

Many approaches to causal inference assume exchangeability (Definition 1.2) and exploit its consequence (Theorem 1.1):

$$\mathrm{E}[Y(x)|X = x'] = \mathrm{E}[Y(x)|X = x]$$

Difference-in-differences makes a weaker exchangeability assumption:

$$\mathrm{E}[Y_t(0) - Y_{t'}(0)|X = 1] = \mathrm{E}[Y_t(0) - Y_{t'}(0)|X = 0]$$

3 Summary

In summary, this book has no content whatsoever.

```
1 + 1
#> [1] 2
```

References

Hernán, MA, and J Robins. 2020. "Causal Inference: What If. Boca Raton: Chapman & Hill/Crc.(2020)." *Publisher's Note Springer Nature Remains Neutral with Regard to Jurisdictional Claims in Published Maps and Institutional Affiliations*. https://miguelhernan.org/whatifbook.

Judea Pearl, Nicholas P. Jewell, Madelyn Glymour. 2016. *Causal Inference in Statistics: A Primer*. 1st ed. Chicester: Wiley.