Causa Nostra: The Potentially Legitimate Business of Drawing Causal Inferences from Observational Data

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Overview

A Triage System for Causal Inference with Observational Data

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- Sometimes G-computation is not enough. Then you need something like propensity adjustments or case-matching (not covered here).

A Simple Example

Kidney Stone Data

TABLE II—*Success rate of treatment* (figures are numbers (%) of patients)*

	Group 1	Group 2	Overall
Nephrolithotomy/pyelolithotomy	12 (92)	154 (71)	166 (72)
Pyelolithotomy	26 (84)	38 (84)	64 (84)
Ureterolithotomy	43 (100)		43 (100)
All open procedures	81 (93)	192 (73)	273 (78)
Percutaneous nephrolithotomy†	234 (87)	55 (69)	289 (83)
ESWL	200 (98)	101 (82)	301 (92)
Percutaneous nephrolithotomy and ESWL		15 (62)	15 (62)

*Success defined as no stones at three months or stone reduced to particles <2 mm in size.
†52 with electrohydraulic lithotripsy, 69 with ultrasound.

Taken From

Taken from: Charig et al., Comparison of treatment of renal calculi by open surgery, percutanesous nephrolithotomy, and extracorporeal shockwave lithotripsy. BMJ 1986;**292**:879–882.

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- Open surgery has better efficacy for subjects with large stones,
- Each subject falls into one of those two categories … and yet:
- Point estimates from the naive analysis imply that percutaneous surgery is better “overall”.

The World's Simplest Example of G-Computation

Overall, 51% percent of patients have small stones and 49% percent of patients have large stones,

So "standardized" response rates are:

$$\text{open:}\ \ 0.51 * 0.93 + 0.49 * 0.73 = 0.83$$
$$\text{percutaneous:}\ \ 0.51 * 0.87 + 0.49 * 0.69 = 0.78$$

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4. Repeat the above steps with treatment now fixed at the other level, “percutaneous surgery”.

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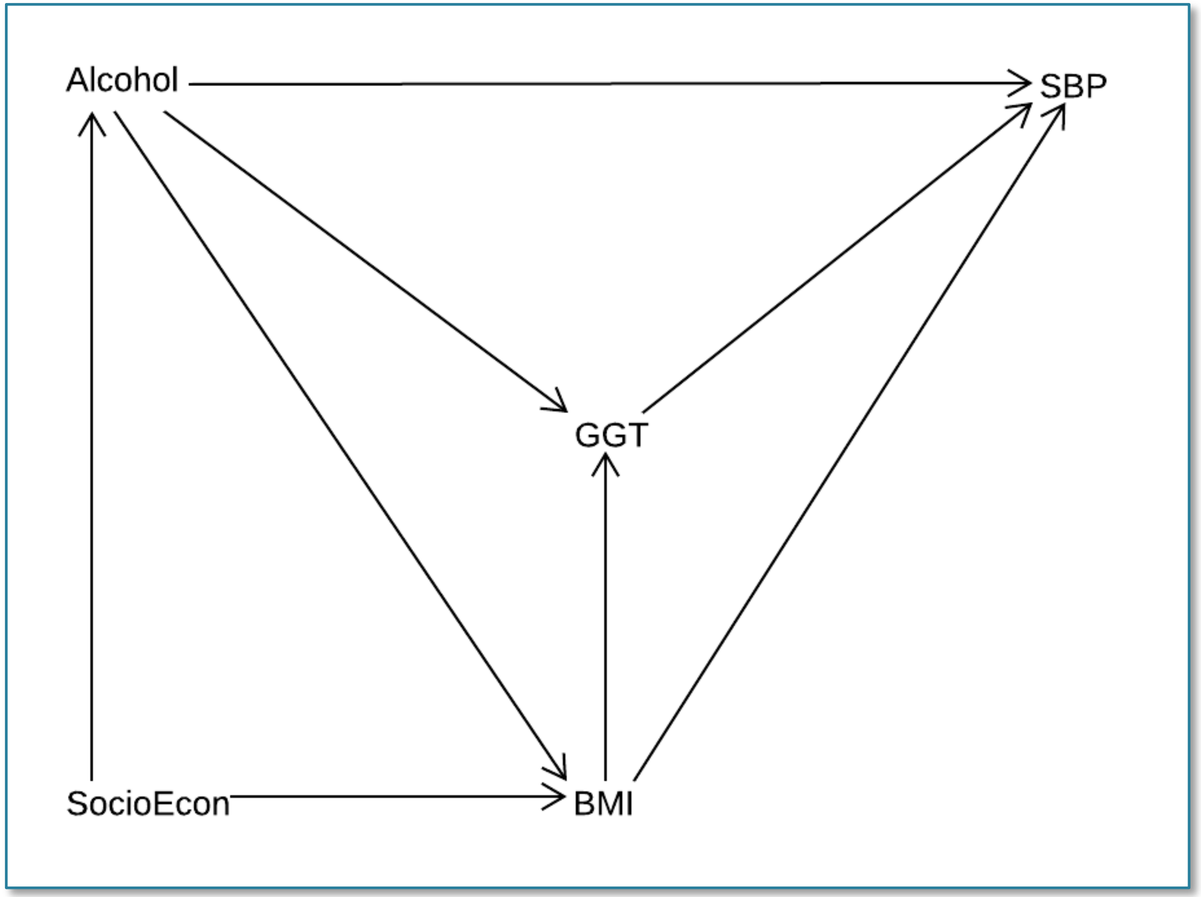
4. Repeat the above steps with treatment now fixed at the other level, “percutaneous surgery”.
5. Compare the two proportions you obtained.

Good News: G-computation Estimates Causal Estimands Correctly

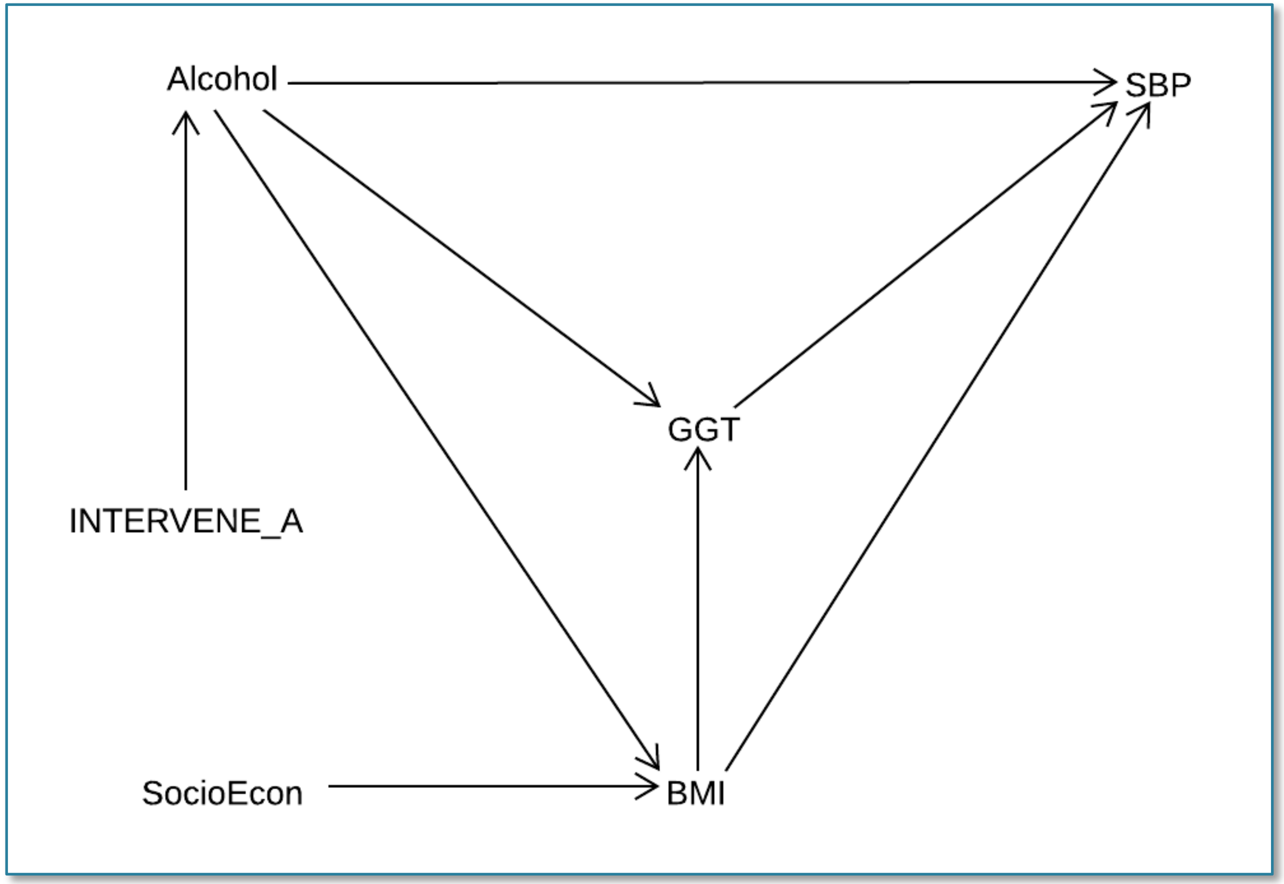
A More Complex Example

Observational Data for Effect of Alcohol Consumption on Systolic BP

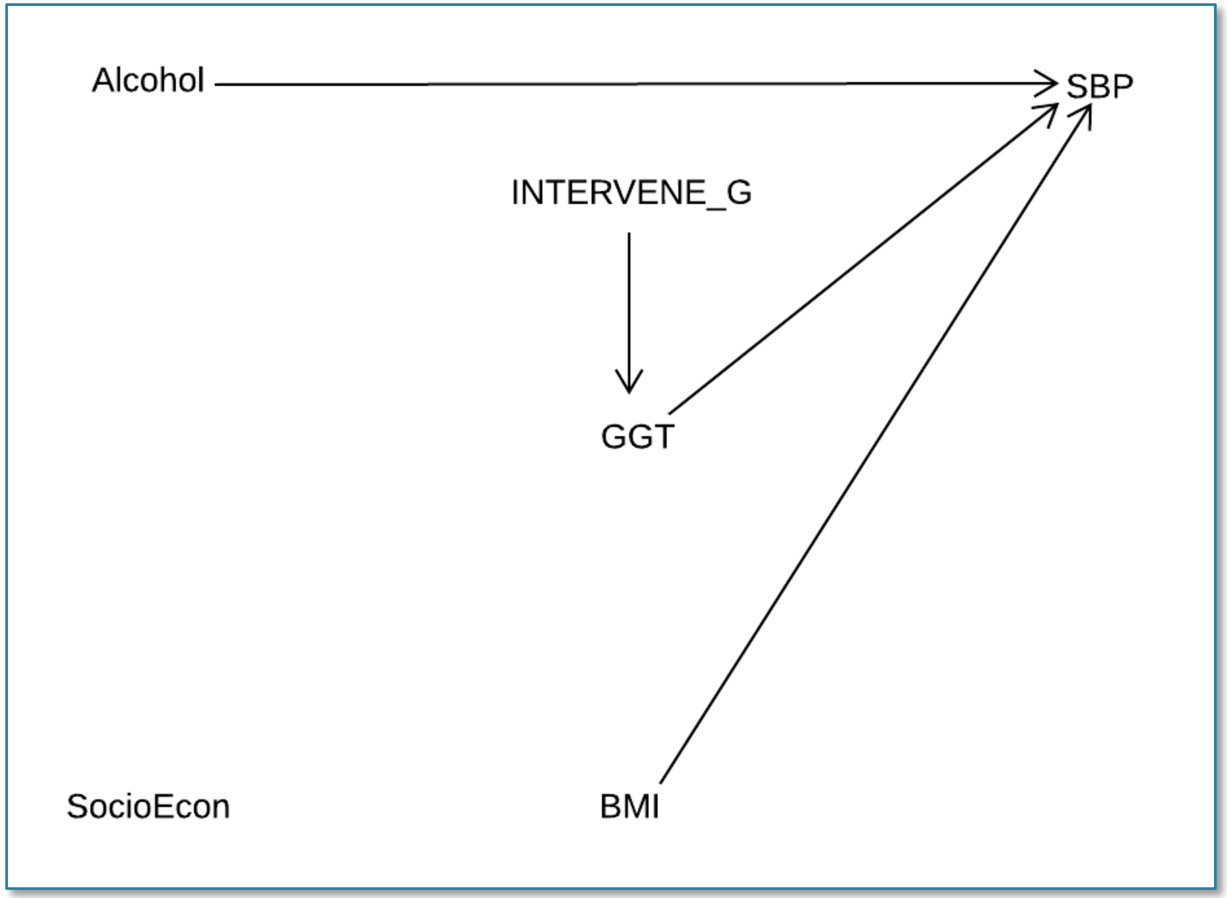


Adapted from: Daniel, et al. gformula: Estimating causal effects in the presence of time-varying confounding or mediation using the g-computation formula. The Stata Journal 2011;**11**:479-517.

Question About Total Causal Effect of Alcohol Consumption on SBP



Causal Effect of GGT When Alcohol Consumption is as Observed



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- If you are in this room, it is highly likely that you base causal inferences on observational data all the time.
- You probably use G-computation. That’s good. It works when you do it right.
- Formal causal diagrams and related concepts like backdoor criteria can help you ensure that you are doing G-computation the right way.

the end