Causal inference in health disparities research and the "No-Multiple-Versions-of-Treatment" assumption

"When I use a word, it means just what I choose it to mean—neither more nor less. —"

Humpty Dumpty, Through the Looking Glass by Lewis Carroll

1

Health disparities research investigates causes of health differences across populations, often relying on **observational data** for causal inference. The **Neyman-Rubin potential outcomes framework** defines causal effects as the difference between **two potential outcomes** (what-if scenarios). It relies on a set of identification assumptions (Figure 1).

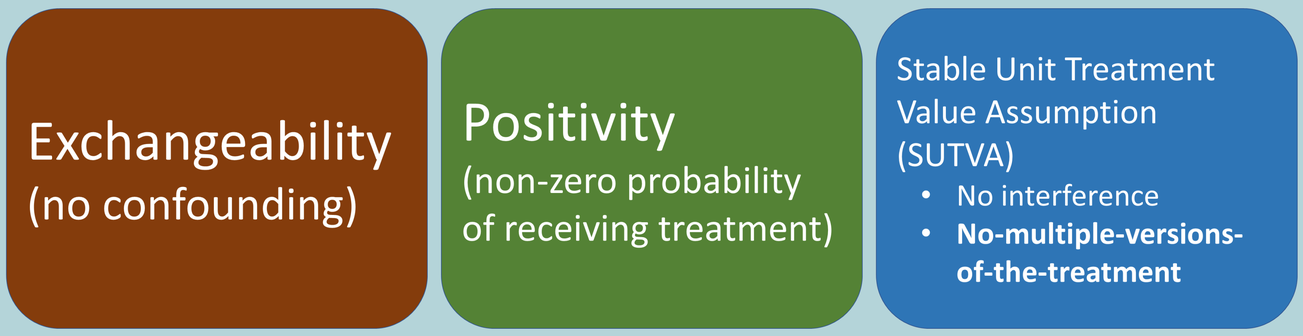

Figure 1. Identification assumptions under the potential outcomes framework.

2

The no-multiple-versions-of-the-treatment assumption implies that:

"… the exposure (treatment) specified in the analysis must have enough precision that any variation within the exposure specification would not result in a different outcome." [1]

Less of a concern in randomized controlled trials because the intervention is pre and well-defined, i.e., the intervention ***means just what the researchers choose it to mean—neither more nor less.***

In health disparities research, the studied exposures often lead to violations of this assumption. However, this is seldom discussed in applications.

3

EXAMPLE: Socioeconomic status (SES)

Looking into the effect of SES on a health outcome ***Y***, specifically the contrast between a scenario where the SES level is set to *Medium* vs the *Low* SES scenario.

SES is often measured as a composite index containing information on Education , Income and Occupation. SES is a "compound treatment".

A *Medium* SES score could be achieved in various ways, which leads to various "**hidden**" versions of the *Medium* SES exposure level as seen in Figure 2.

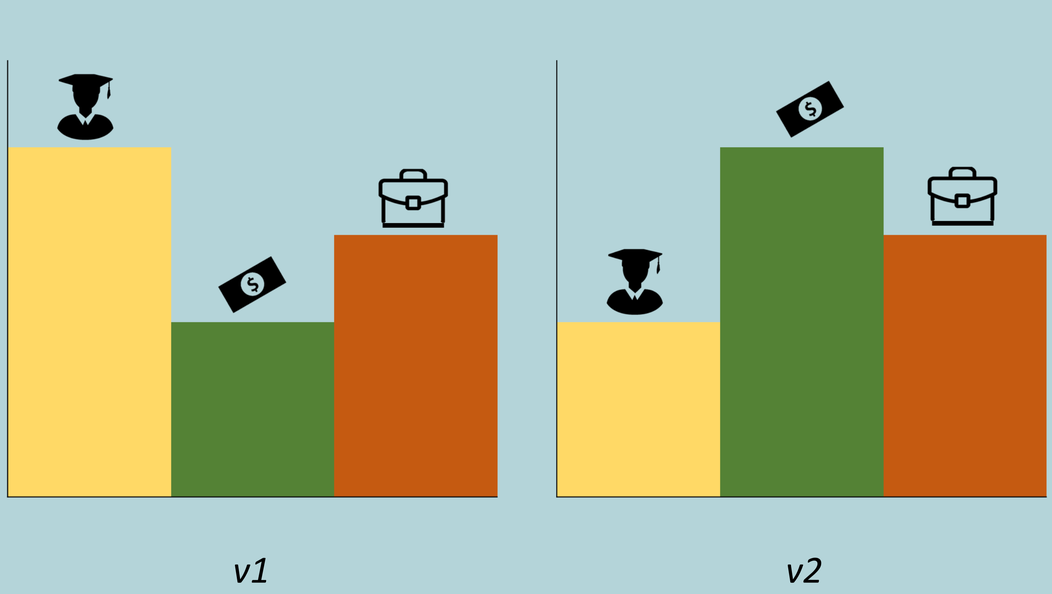

Figure 2. Examples of "hidden" version of the exposure *Medium* SES"

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To avoid a violation of this assumption, it is important that regardless of which component of SES is changed, the same effect would occur

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In the example, we show multiple versions of the exposure *Medium* SES. The issue arises when each version could lead to a different outcome, i.e., when $Y_{v1} \neq Y_{v2}$.

From previous research, it is known that different components of SES have a different impact on health outcomes. Thus, each version is likely to lead to a different outcome, i.e., SES as exposure is not **well-defined**.

Main consequences:

- We would not know **which causal contrast** is being estimated from the data, i.e., which causal effect, if any, is being estimated. Difficult to justify the use of estimates for decision-making.[2]
- Different versions might require different sets of covariates for adjustment, opening **back door** paths we are unaware of.
- Violations of this assumption could explain (in part) the **heterogeneous results** obtained in health inequalities research and replicability issues.

The No-Multiple-Versions-of-Treatment assumption implies a well-defined research question.

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Considerations

- If data collection is planned, predefine the **causal contrast** (research question) to be estimated as precisely as possible.
- For composite measures (e.g. SES), consider the analysis of the components separately.
- When using registry or pre–collected data neither option above might be available to the researchers.
- In certain scenarios, it is plausible to identify an "overall treatment effect" even under violations of this assumption.[2-3]

References

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2. Hernán M.A, VanderWeele T.J. Compound Treatments and Transportability of Causal Inference. Epidemiology, (2011).
3. VanderWeele T.J, Hernán M.A. Causal Inference Under Multiple Versions of Treatment. J Causal Inference, (2013).

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