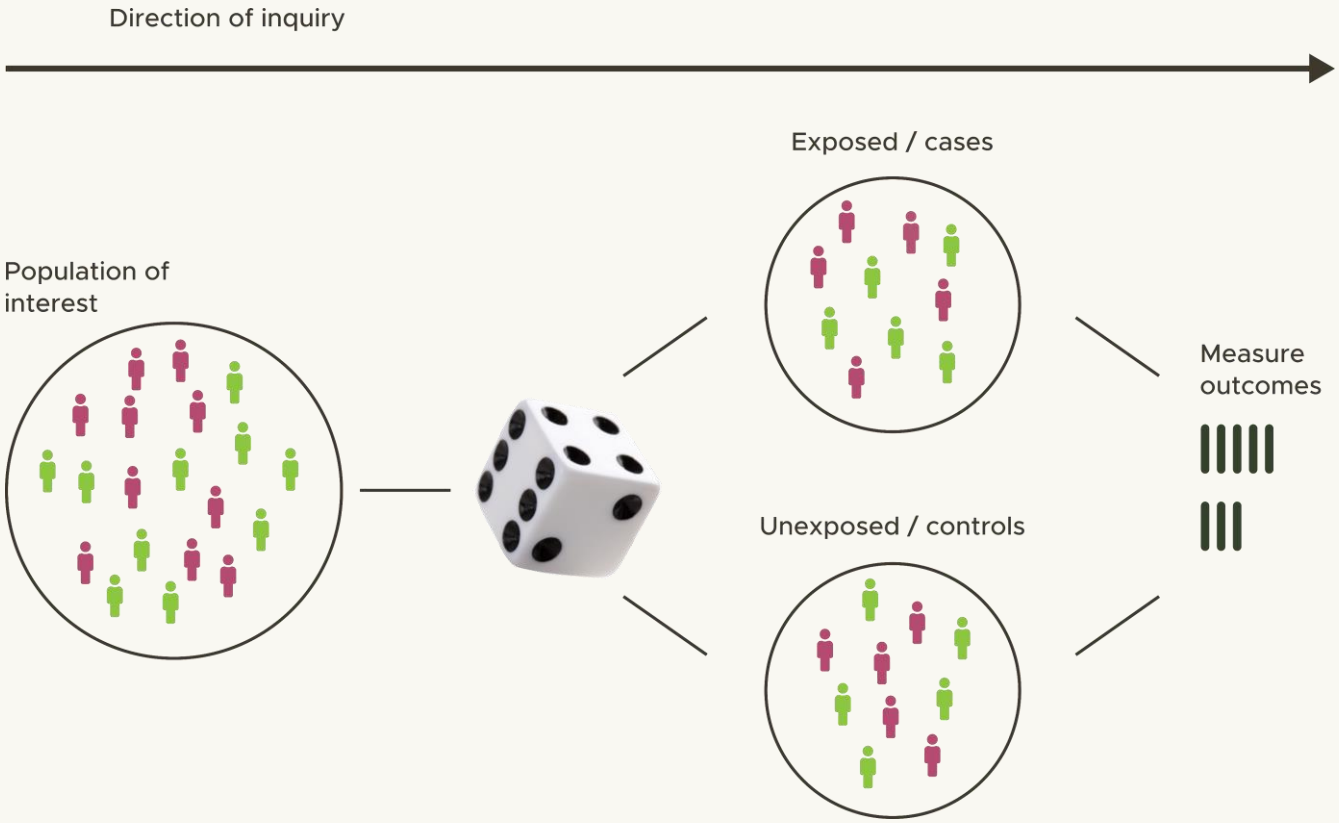
The Strategy Unit.

3.01 The retrospective matched controls design: introduction

NHS-R workshop no. 4 | February 2019

NHS
Midlands and Lancashire
Commissioning Support Unit

The gold standard: a randomized experiment

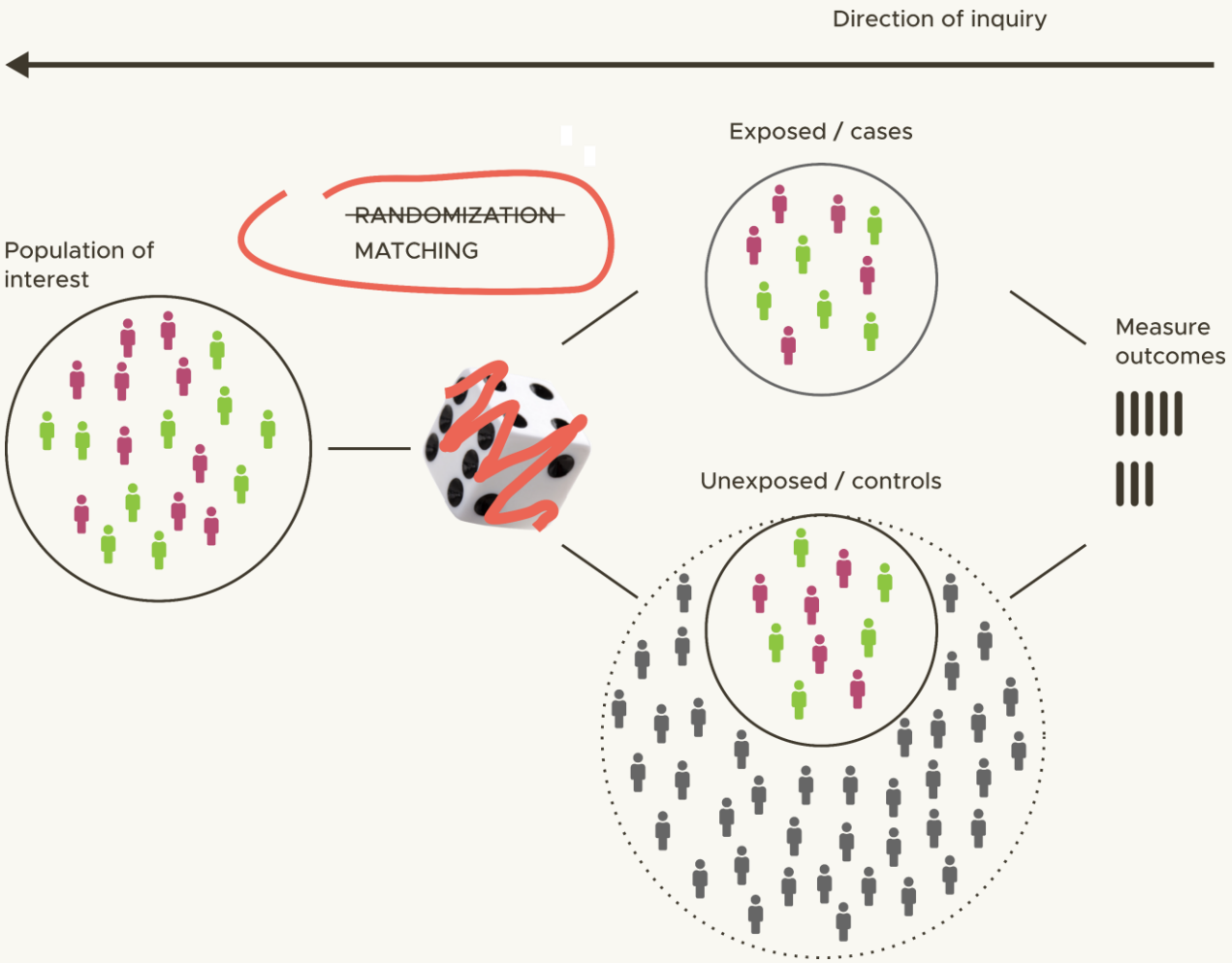


Important features of a randomized experiment

- objectivity of treatment assignment (unbiased estimates)
- balance on covariates (observed and unobserved)
- prospective—no access to outcome data (prevents cheating/p-hacking)

> One of the key benefits of randomized experiments for estimating causal effects is that the treated and control groups are guaranteed to be only randomly different from one another on all background covariates, both observed and unobserved. Work on matching methods has examined how to replicate this as much as possible for observed covariates with observational (non-randomized) data.

The retrospective cohort study design



Important questions to ask about observational study designs

- what was the hypothetical randomized experiment that led to the observed dataset?
- are sample sizes in the dataset adequate?
- who are the decision makers for treatment assignment and what measurements where available to them?
- are the key covariates measured well?
- can balance be achieved on key covariates?

> A crucial idea when trying to estimate causal effects from an observational dataset is to conceptualize the observational dataset as having arisen from a complex randomised experiment, where the rules used to assign the treatment conditions have been lost and must be reconstructed.

Rubin D. For objective causal inference, design trumps analysis. *The Annals of Applied Statistics*. 2008;2(3):808-840. doi.org/10.1214/08-aoas187

> Matching is any method that aims to equate (or “balance”) the distribution of covariates in the treated and control groups.

Treated

Treated

Controls

Why would you use this study design?

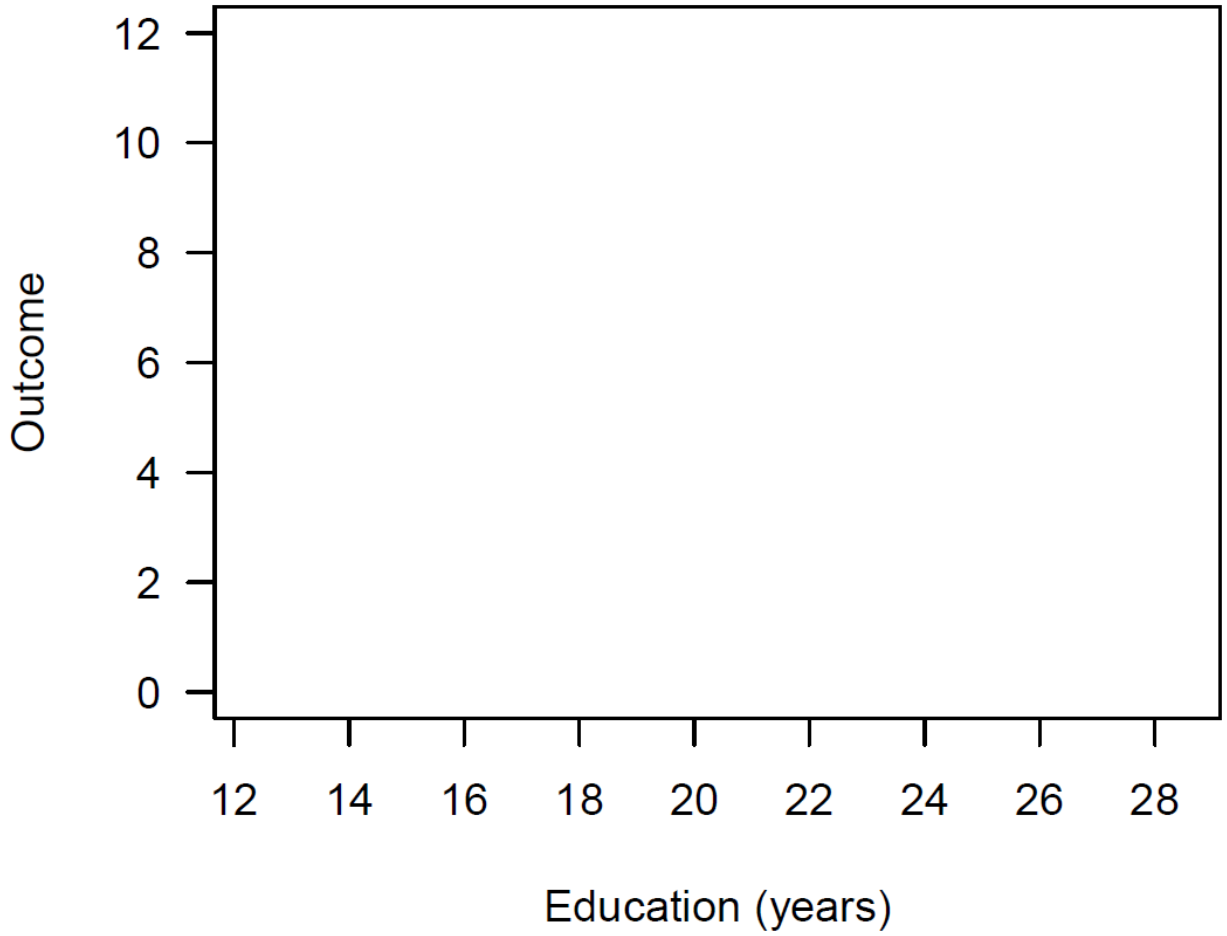
Can be used prospectively where outcomes are not yet known and matching is used to select subjects for follow-up (can reduce cost by limiting size of control group). Or retrospectively, when all the outcome data is already available, and the goal of the matching is to reduce bias in the estimation of the treatment effect.

Controlling for confounders is achieved at the design phase without looking at the outcome—the difficult statistical work can be done blinded to the outcomes.

Alternatives to matching methods include adjusting for background variables in a regression model. The advantage of matching is …

Matching to Reduce Model Dependence

(Ho, Imai, King, Stuart, 2007: fig.1, *Political Analysis*)



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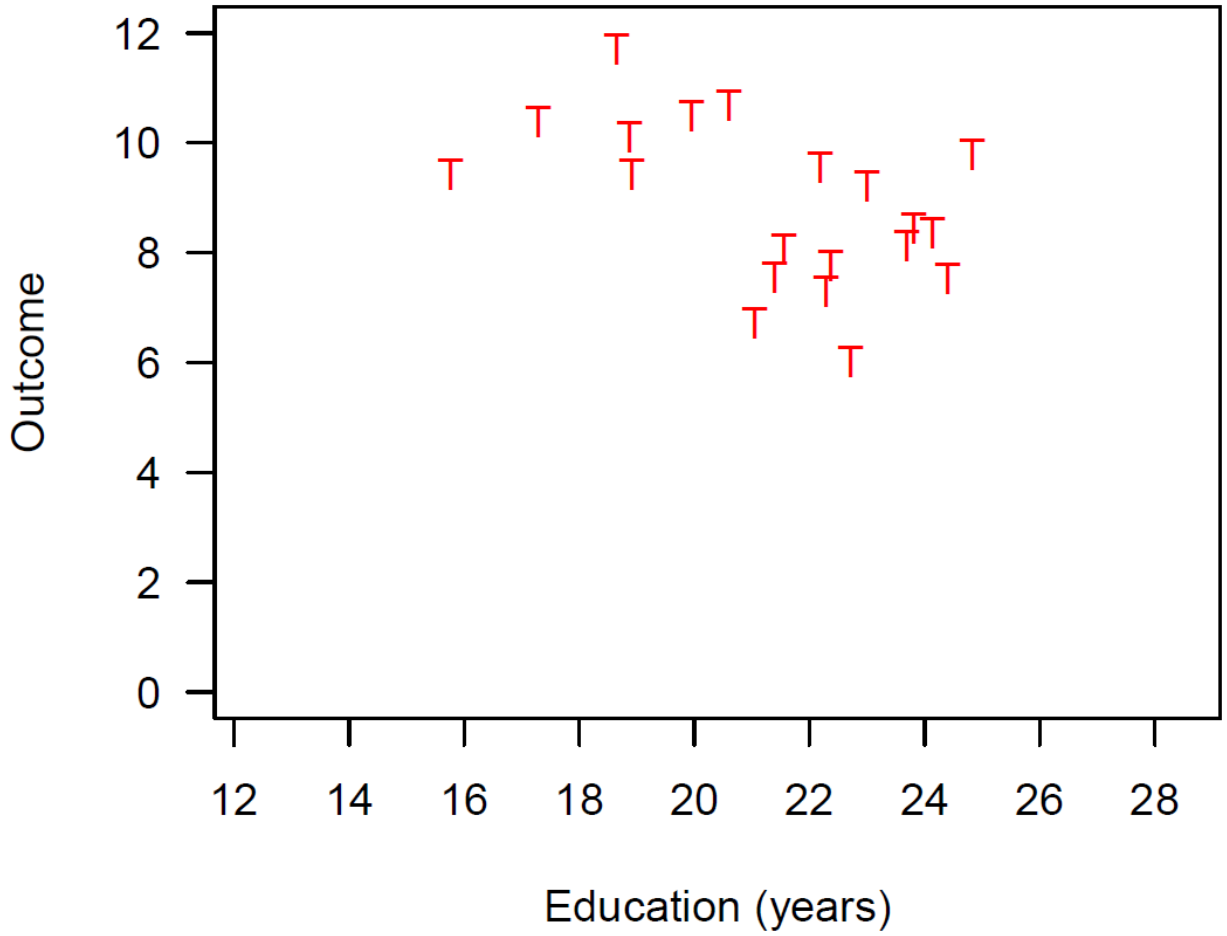

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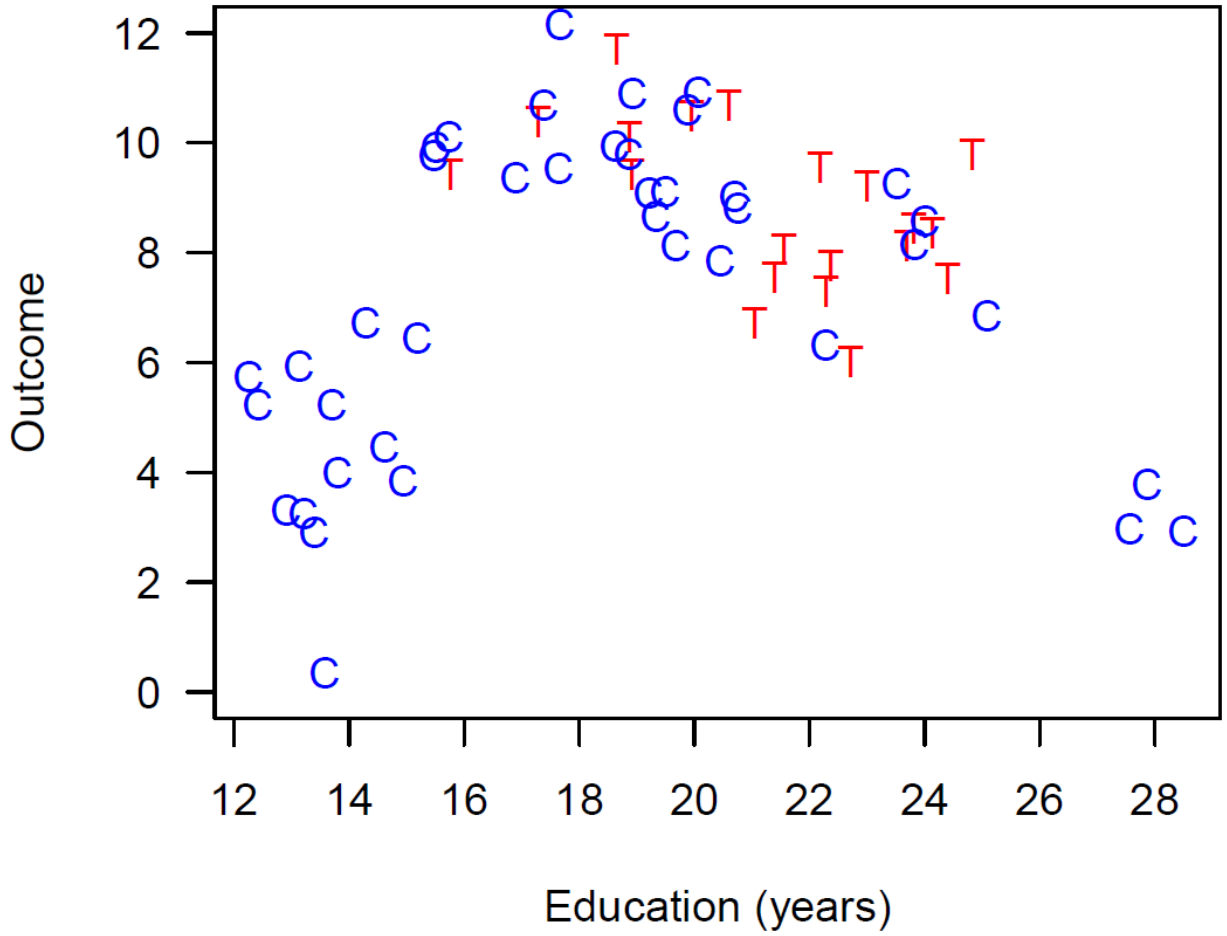

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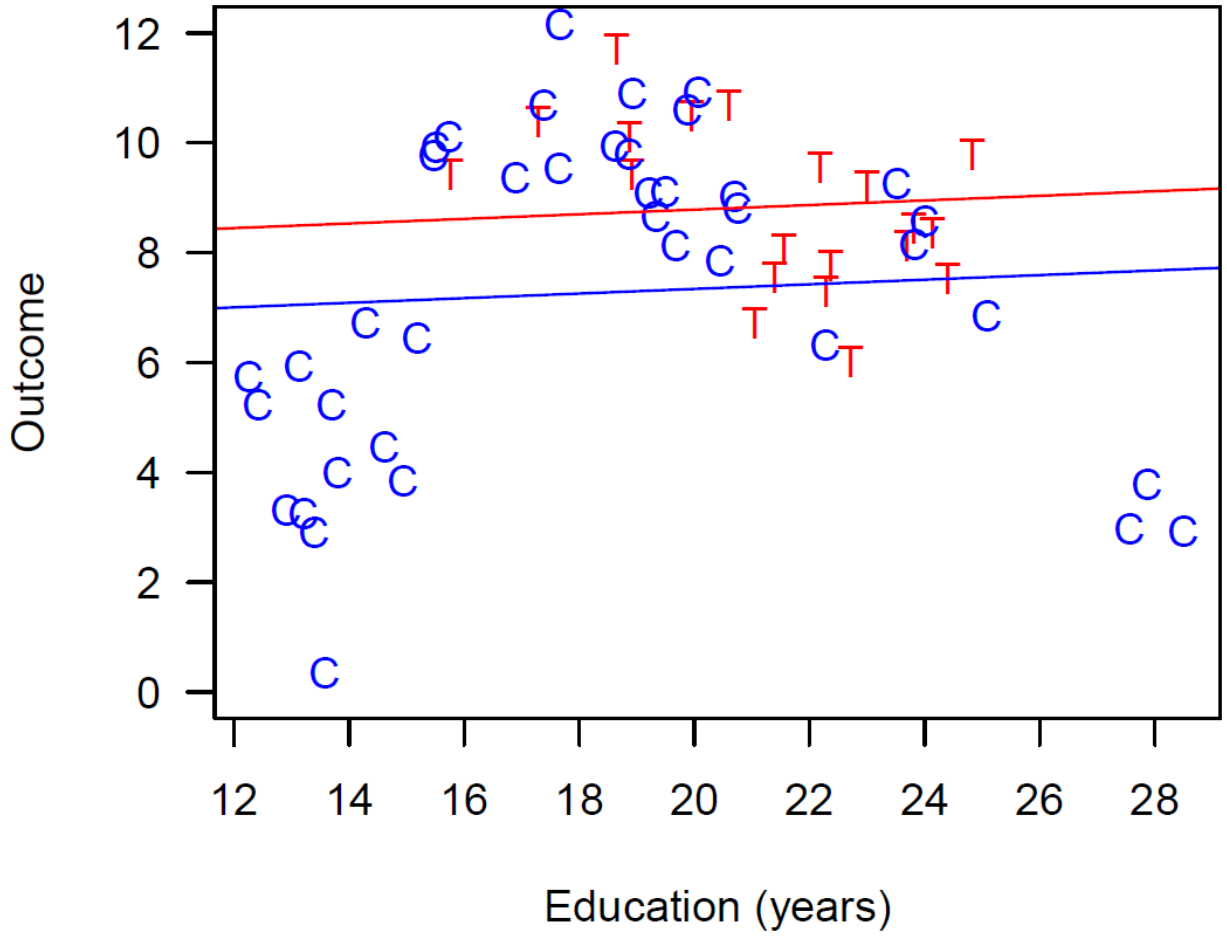

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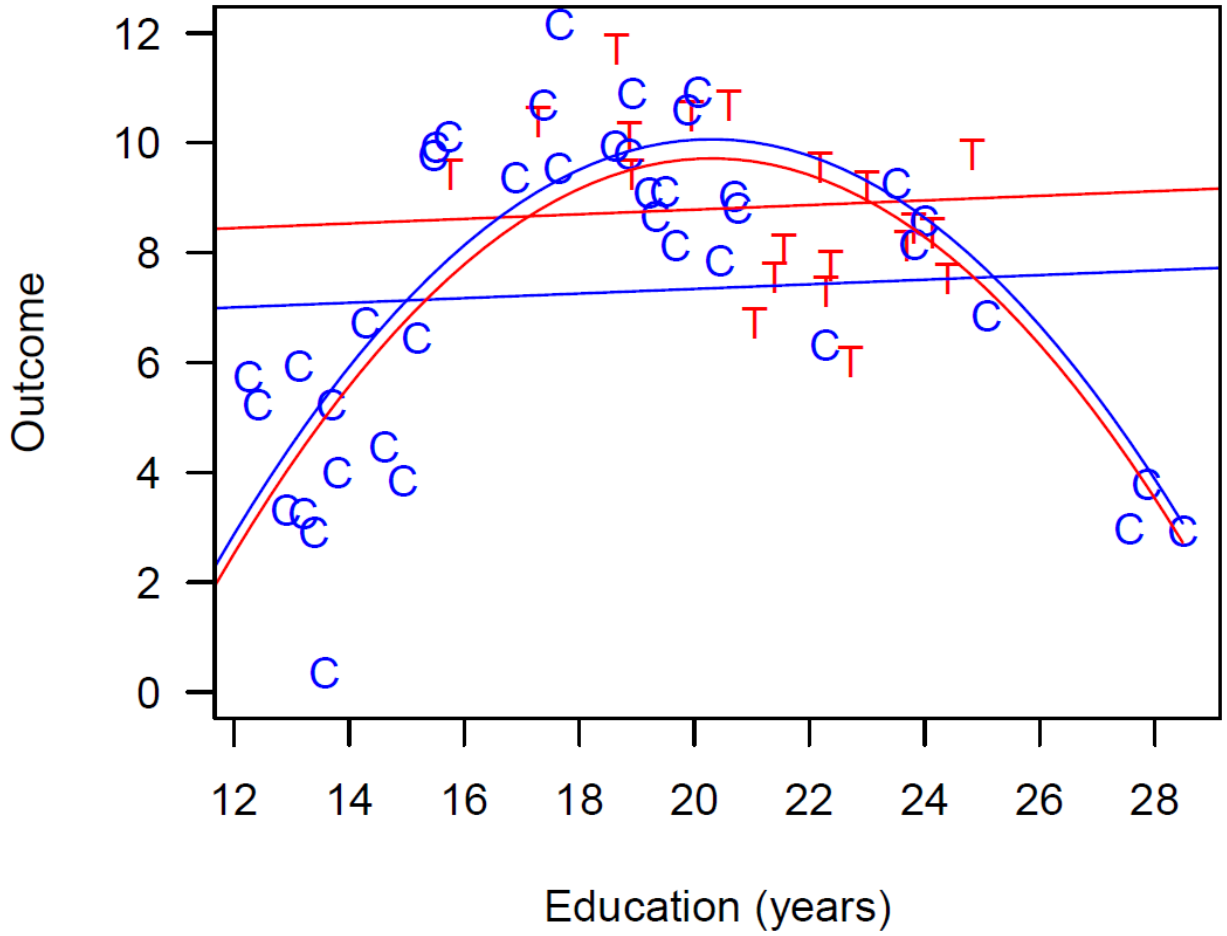

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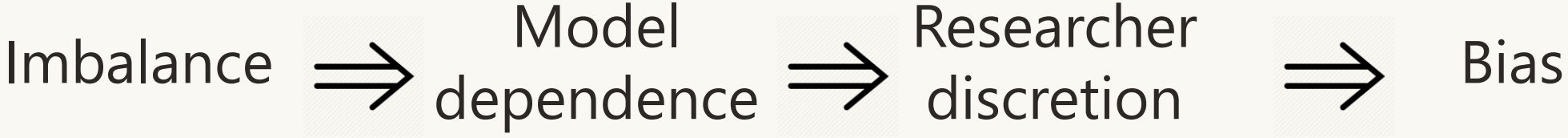
Without matching:



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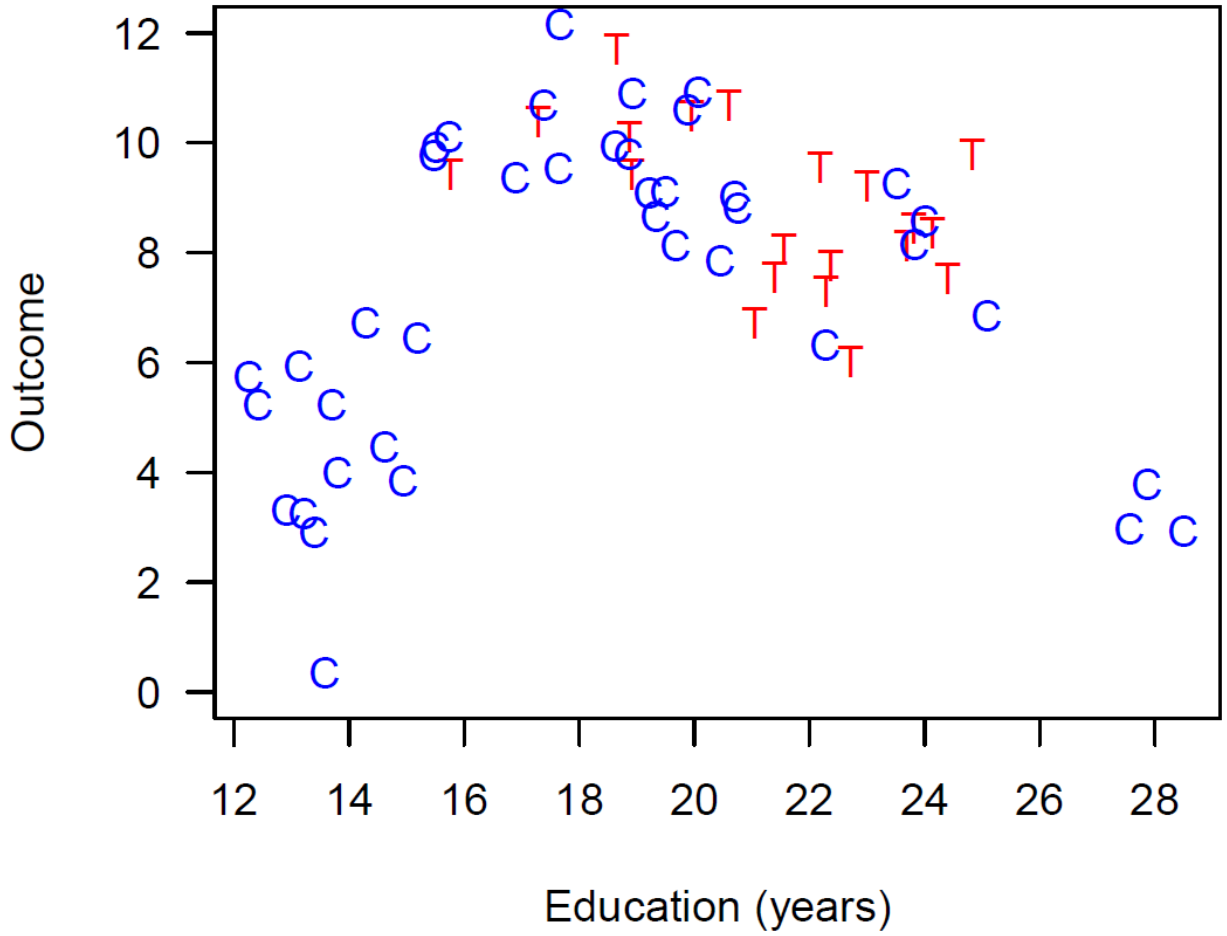

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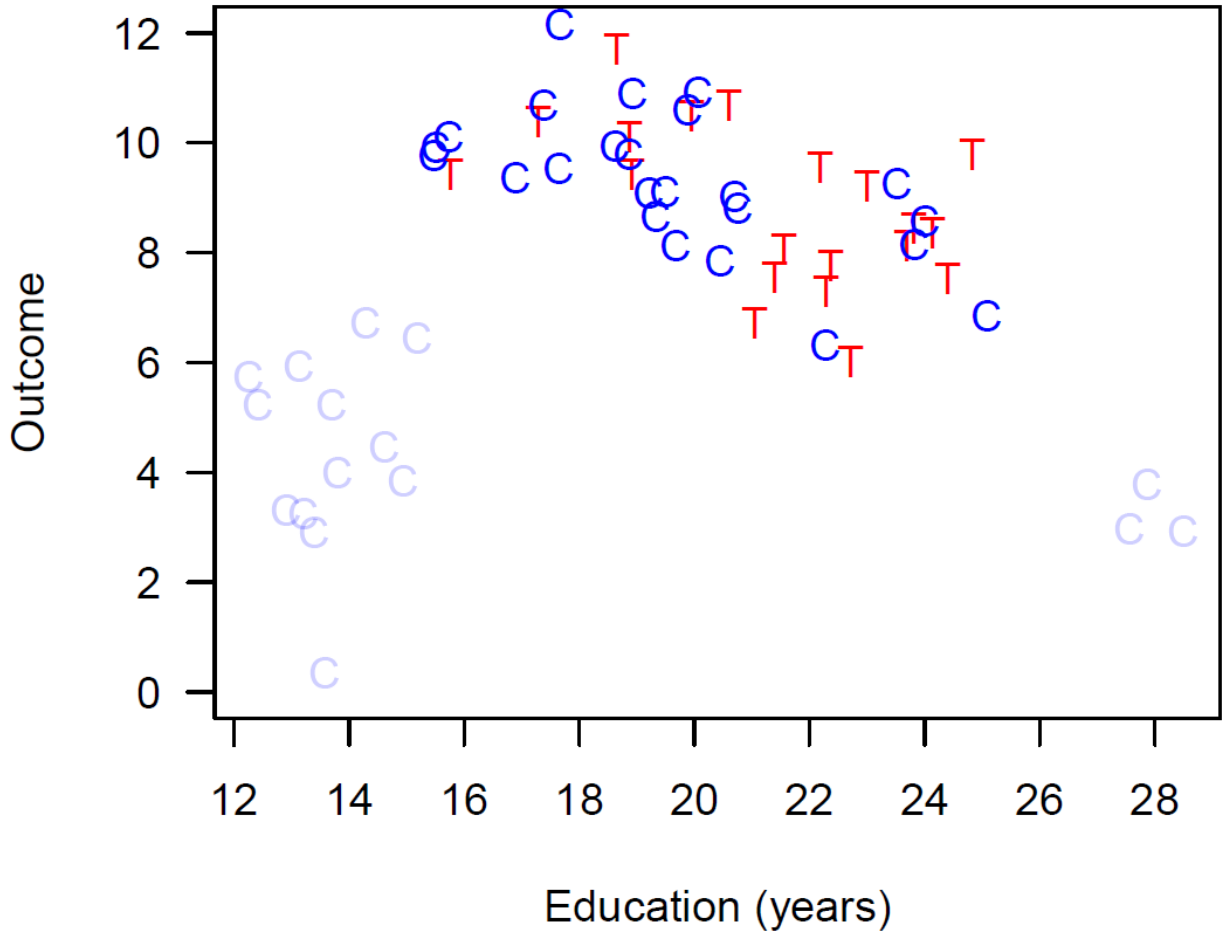

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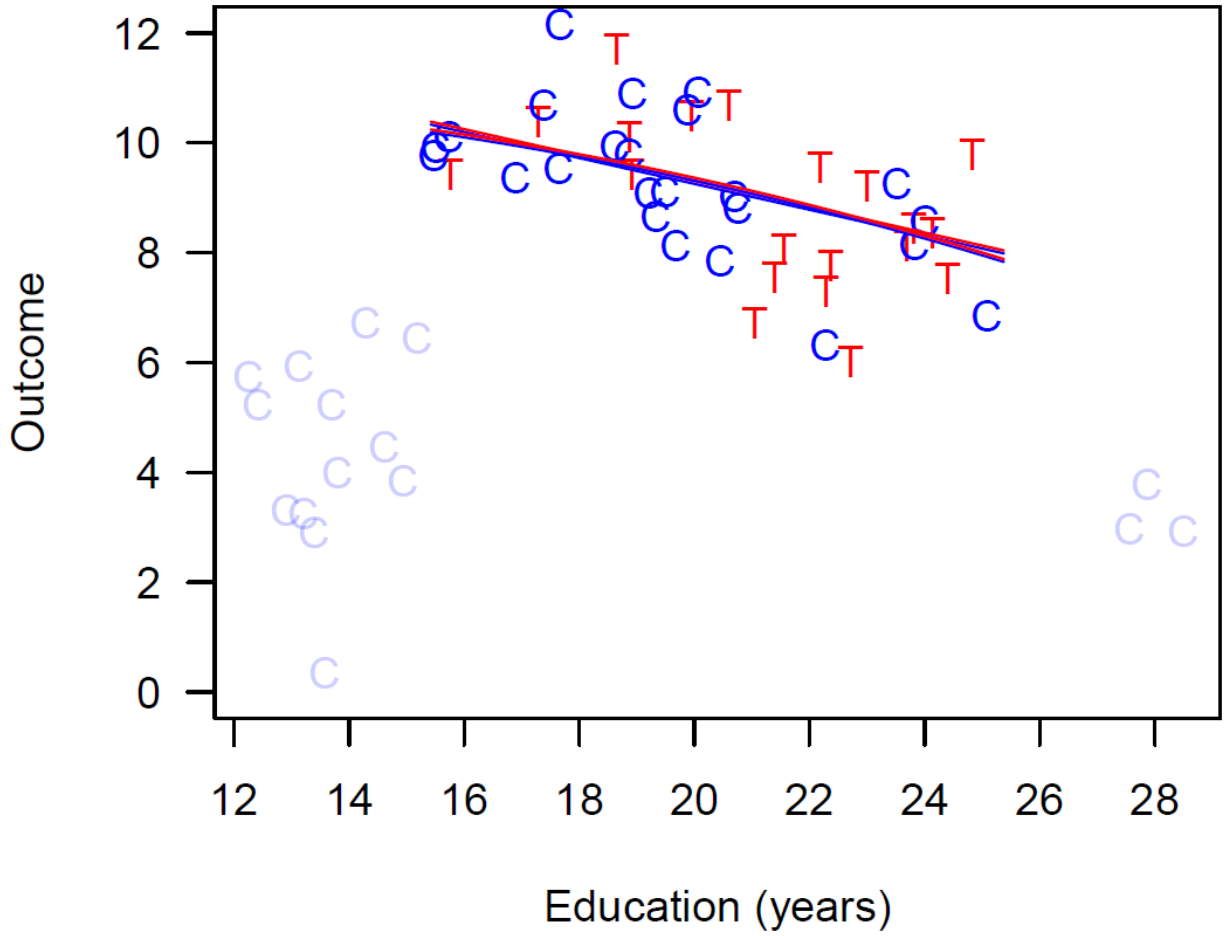

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With~~out~~ matching:

Im~~balance~~ ⇒ ~~Model dependence~~ ⇒ ~~Researcher discretion~~ ⇒ ~~Bias~~

Why would you use this study design?

Matching methods should not be seen in conflict with regression adjustment and in fact the two methods are complementary and best used in combination.

Matching methods have straightforward diagnostics by which their performance can be assessed.

Matching will reveal lack of overlap in covariate distribution such that the resulting treatment effect estimates would rely heavily on extrapolation.

Once data are matched, essentially treat as if from a randomized trial, meaning outcome analysis can be simple.

Data requirements

Knowledge of decision-making about treatment assignment

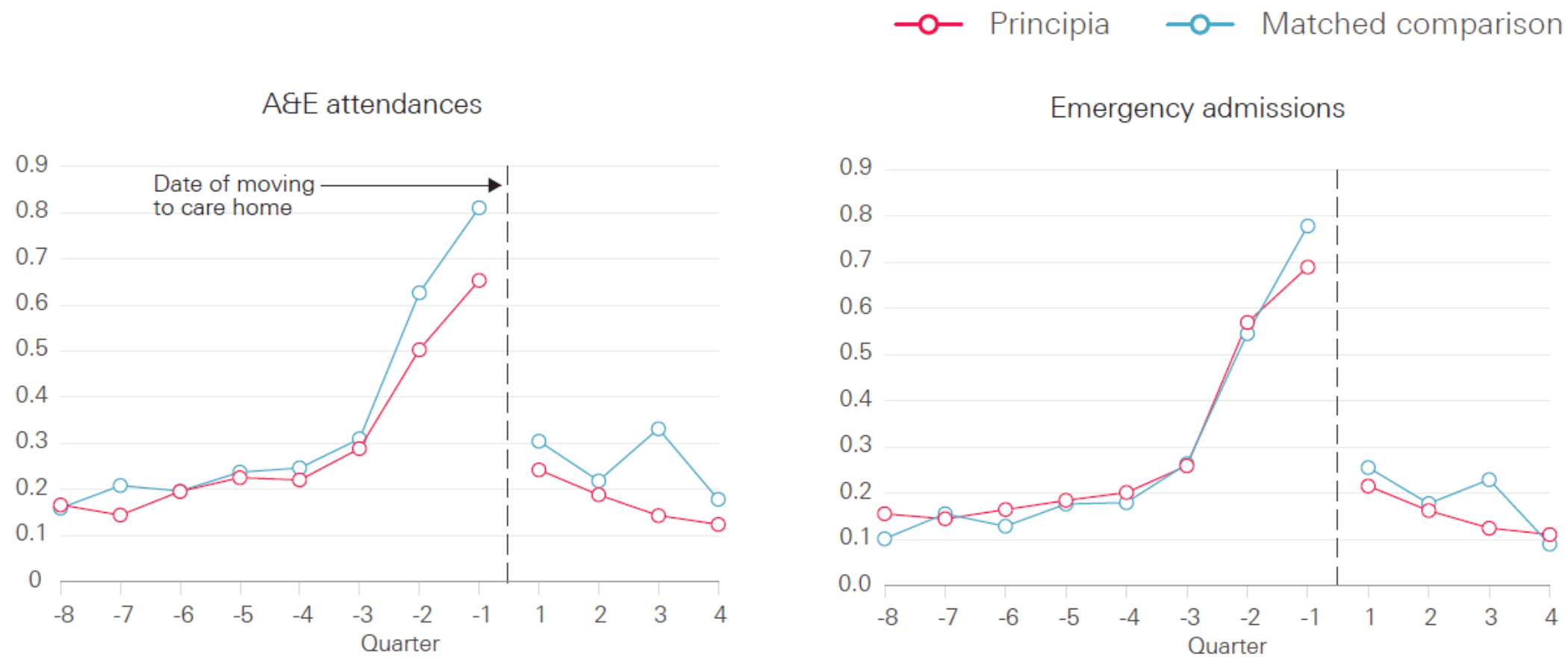
Information on important covariates

Well measured outcome

Sample size—you will often need many more controls than cases

The impact of providing enhanced support for care home residents in Rushcliffe

Figure 3: Number of hospital contacts per quarter for the Principia and matched comparison residents



Limitations and mitigations

- Missing data
- Violation of ignorable treatment assignment
- Choosing between matching methods

Summary

Can be undertaken prospectively or retrospectively

Closely approximates a randomized experiment—confounders are adjusted for in the design phase.

Matching reduces model dependence; but requires information on important covariates.

Clear diagnostics for assessing “balance” and opportunity to iterate

Impossible to rule out the existence of unobserved variables related to both treatment assignment and the outcome (violating the assumption of ignorable treatment assignment) biasing the treatment effect estimates.

No clear consensus on optimal matching method; matching can be computationally intensive.

A1: Studies using this design

Nakahara S, Tomio J, Takahashi H, Ichikawa M, Nishida M, Morimura N *et al*. Evaluation of pre-hospital administration of adrenaline (epinephrine) by emergency medical services for patients with out of hospital cardiac arrest in Japan: controlled propensity matched retrospective cohort study. *BMJ*. 2013;347(dec10 1):f6829-f6829. doi: 10.1136/bmj.f6829

Röttger J, Scheller-Kreinsen D, Busse R. Patient-Level Hospital Costs and Length of Stay After Conventional Versus Minimally Invasive Total Hip Replacement: A Propensity-Matched Analysis. *Value in Health*. 2012;15(8):999-1004. doi.org/10.1016/j.jval.2012.06.008

Lloyd T, Wolters A, Steventon A. *Briefing: The impact of providing enhanced support for care home residents in Rushcliffe*. Available from https://www.health.org.uk/publications/the-impact-of-providing-enhanced-support-for-care-home-residents-in-rushcliffe

Strategy Unit. *Evaluation of an Integrated Mental Health Liaison Service (RAID) in Northern Ireland*. Available from https://strategyunitwm.nhs.uk/publications/evaluation-integrated-mental-health-liaison-service-raid-northern-ireland