The Performance of Different Confounders Standardise Mean Difference Balance Criteria in Cardinality Matching for Medical Device Epidemiology: A Simulation Study

By Mike Du

Supervisors: Prof Daniel Prieto-Alhambra, Dr Sara Khalid, Dr Victoria Strauss

Introduction

- Cardinality matching is a 1 to 1 matching technique that uses integer programming to find the largest matched sample that satisfy a set of pre-define criteria.
- Recent researches have shown it can be use to find matched sample from real world data for causal inference and have advantages over propensity score matching in terms of sample retention in dataset with limited overlap between the treatment groups.
- However little research have been done on applying this method on medical device data with cluster data structure.

Cardinality Matching

1. Specify matching criteria on confounders to balance.

a) Decide on a distance statistics (e.g. Absolute standardise differences)

b) Decide on which Confounders to include

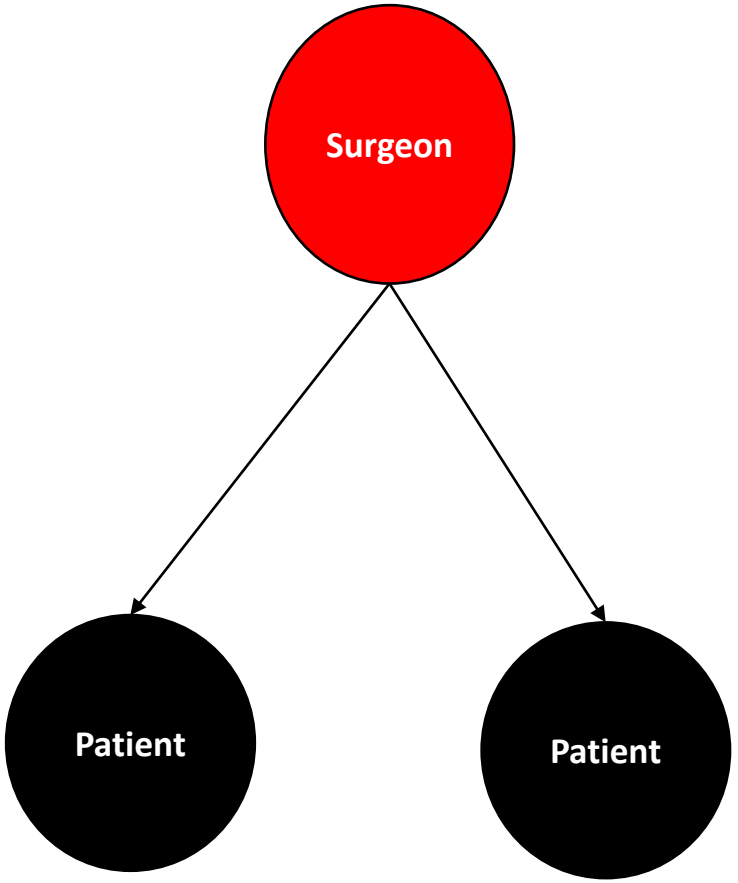
c) Decide on the maximum limit on the distance statistics you specified for the matching criteria

Then the integer programming algorithm will find the maximum matched sample that satisfied the matching criteria you set.

Simulation study

- **Aim:** Compare the performance of different confounder balance criteria strategy for Cardinality matching for estimating treatment effects for medical device epidemiology studies with surgeon impact.

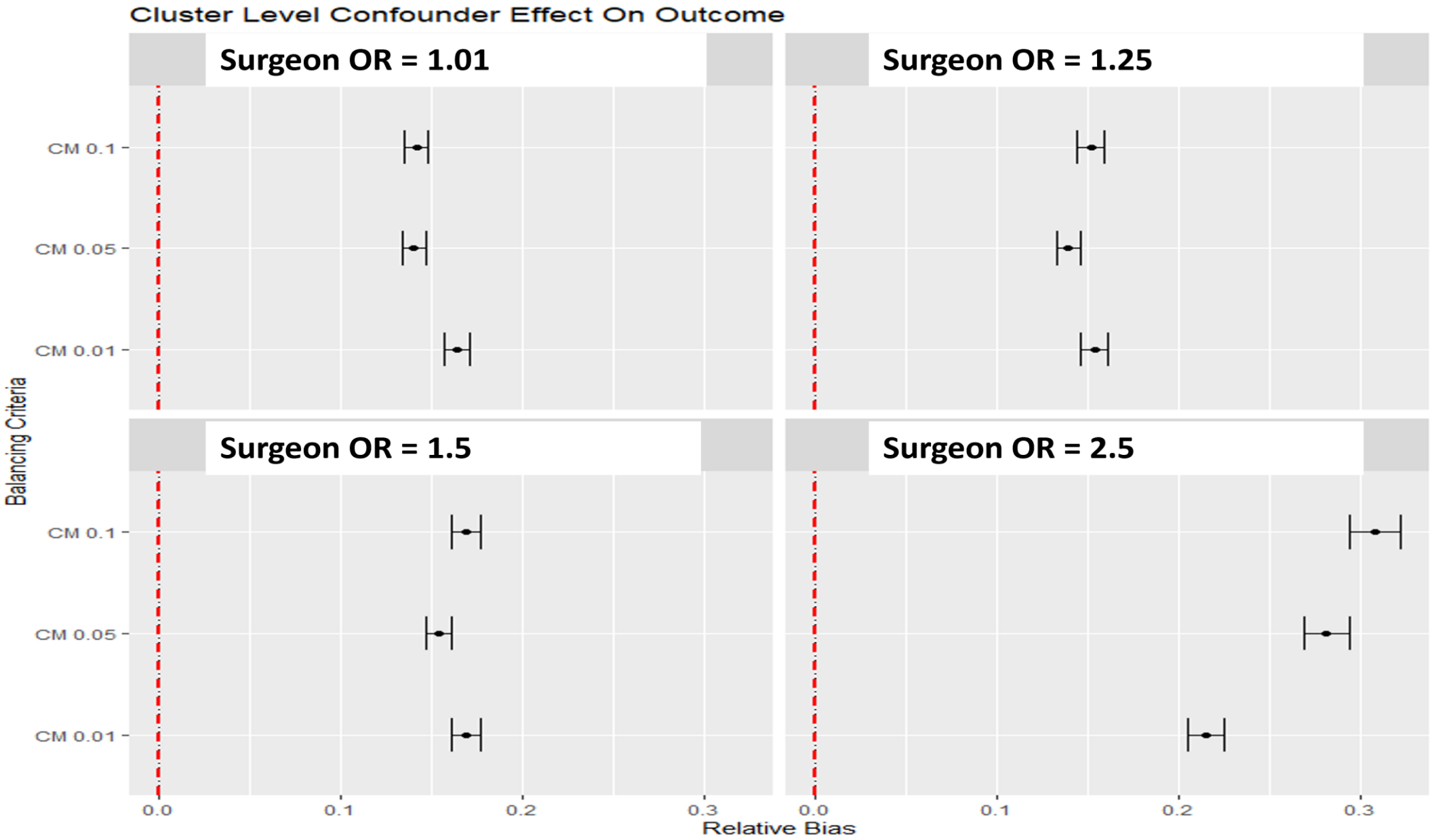
- **Data:** A clustered dataset with 500 surgeons and each surgeons have 20 patients nested under. It contains 5 patient level confounders and 1 surgeon level confounders. The outcome and treatment allocation of the data are binary. Several different surgeon confounders effect on outcome are scenario are tested.



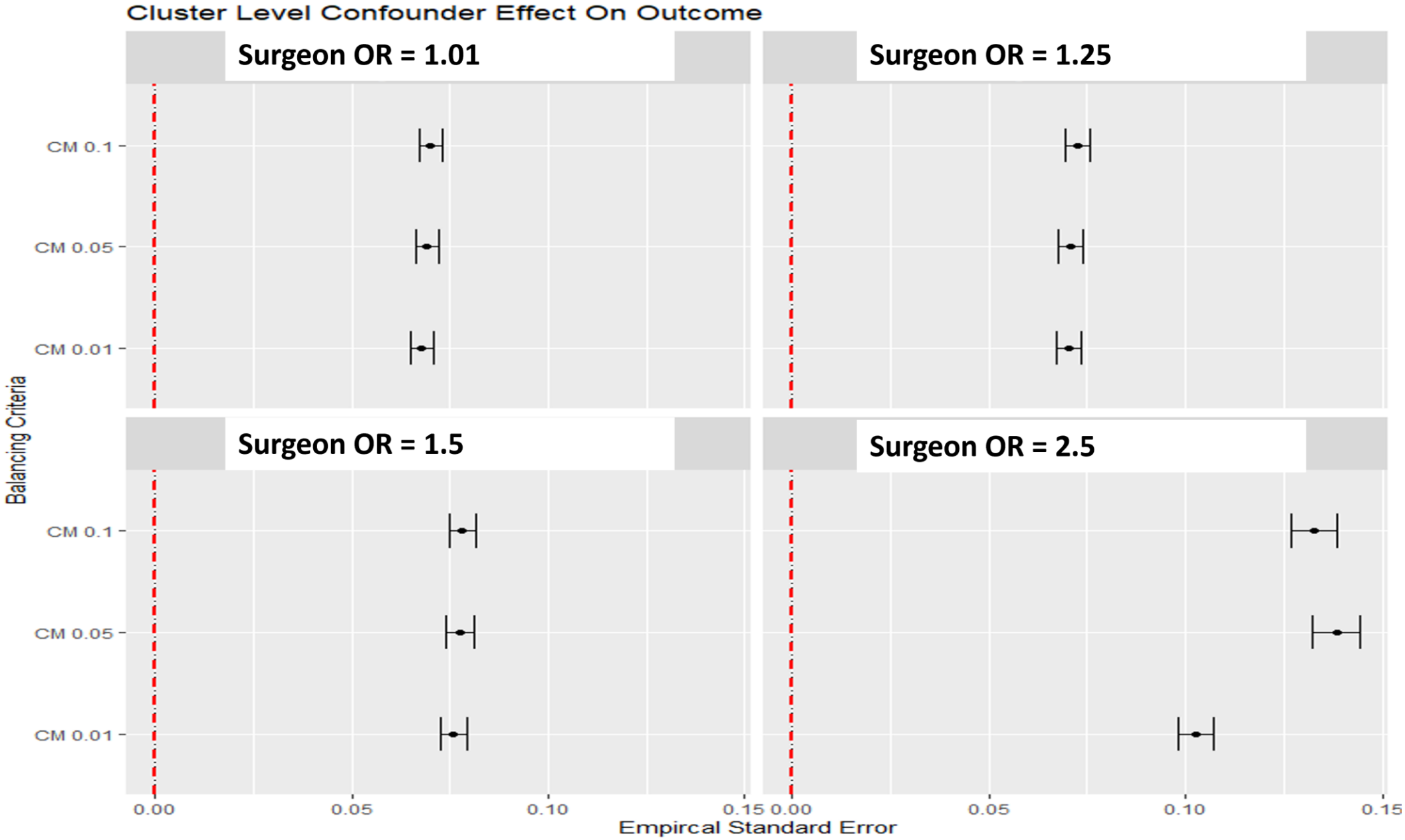
Balancing Criteria Strategy

- Including all confounders as a balancing criteria (both surgeon level and patient level)
- Distance statistics used for the balancing criteria absolute standardise differences
- Several different maximum limit on absolute standardise differences for the balancing criteria are tested. (0.01, 0.05, 0.1)
- Treatment effect are estimate using logistics regression model on the matched sample.

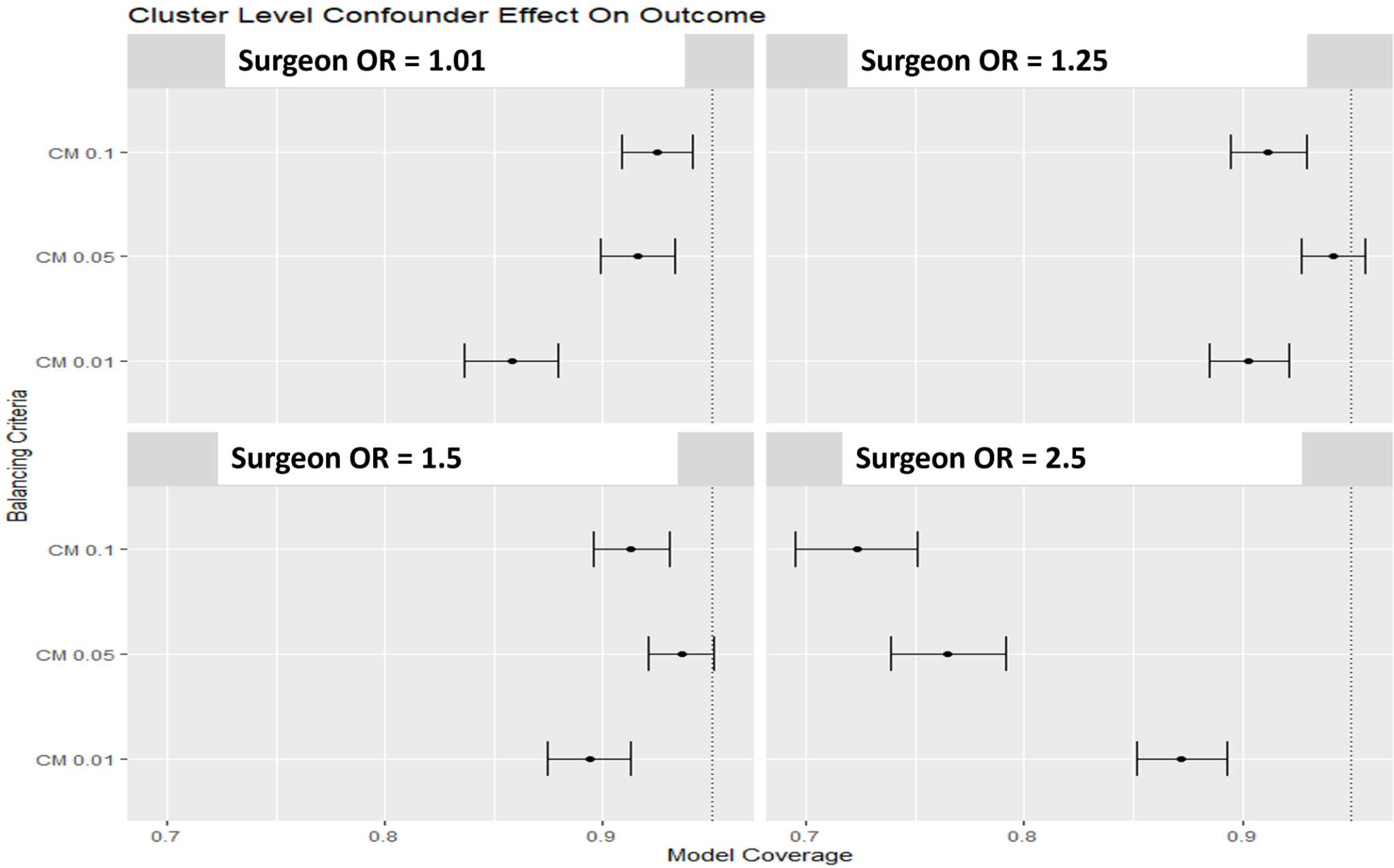
Relative bias for different balancing criteria strategy



Standard error for different balancing criteria strategy



95% Model coverage for different balancing criteria strategy



Discussion

- It is important to consider the limit of the balancing criteria and the surgeon effect on outcome when using cardinality matching for causal inference for cluster data.

- No one size fits all, as shown in the results the optimal criteria limit differ for different surgeon effect size on outcome.

- It is worth running the analysis with several different limits, then decide on the strategy to use.

Limitations

- The simulation study assume the cluster size are fixed for all cluster. Unlikely to be fix for real data.

- Only considered same criteria limit for all confounders. It has the flexibility to apply different limit for different confounders.

- Didn’t offer performance comparison to other methods (e.g. propensity score matching)

Acknowledgements

- **Supervisors**
- Prof Daniel Prieto-Alhambra
- Dr Sara Khalid
- Dr Victoria Strauss

- **Everyone in Pharmaco & Device Epi Group at Ndorms university of oxford.**