Enhancing Interpretation of PSM through Advanced Visualization

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Agenda

01 Why PSM?

02 Challenges

03 Advanced Data Visualization

04 Case Study

05 Conclusion & Future Directions

Why PSM?

Balance Groups

Align treatment & control; adjust baseline differences

Reduce Bias

Control confounders; improve causal inference

Real-World Data

Simulate RCT-like comparability; enhance credibility

Confounding

Address systematic differences

Match by Score

Pair subjects using treatment probability

Challenges

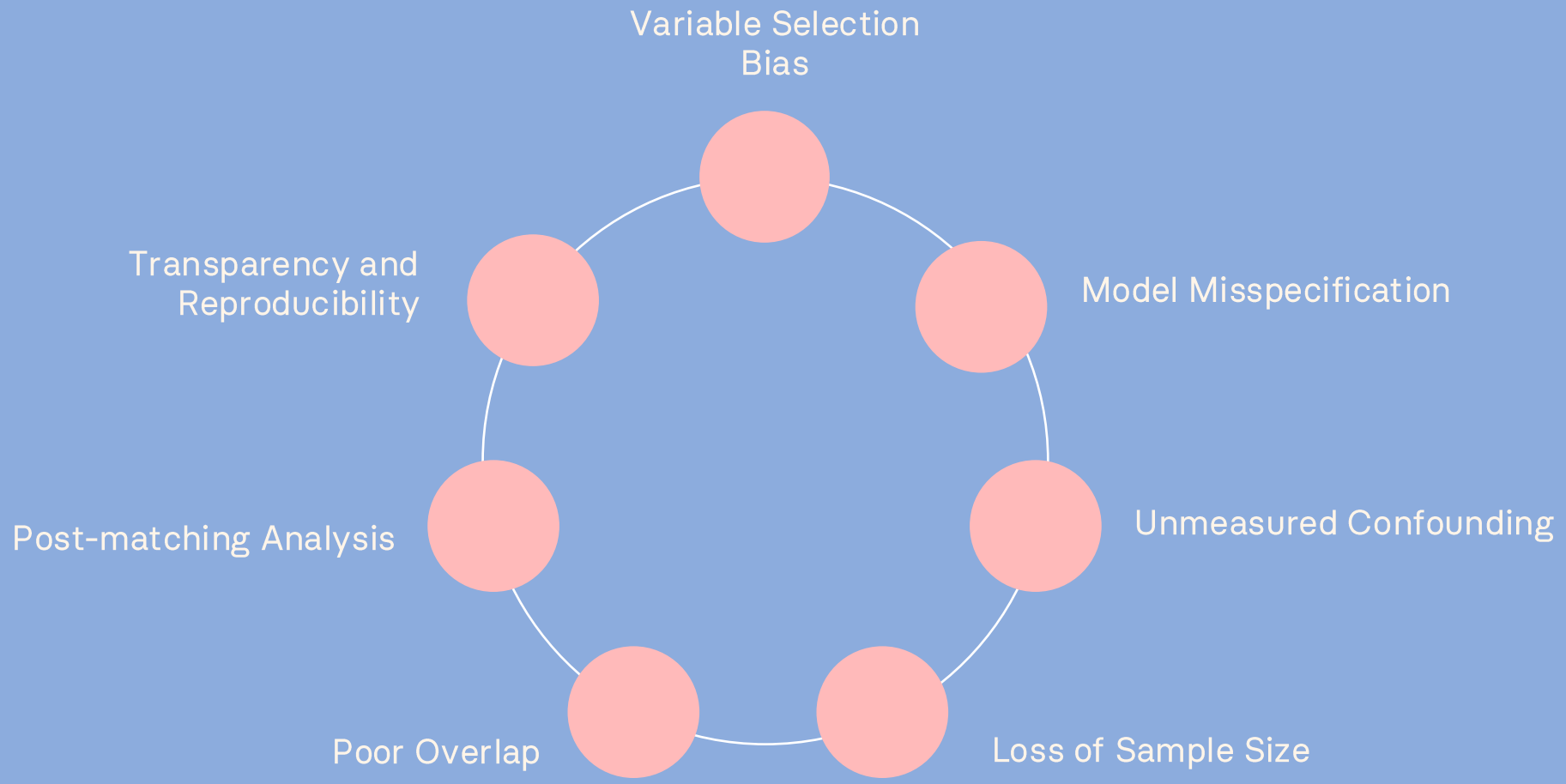

Variable Selection Bias
Model Misspecification
Unmeasured Confounding
Loss of Sample Size
Poor Overlap
Post-matching Analysis
Transparency and Reproducibility

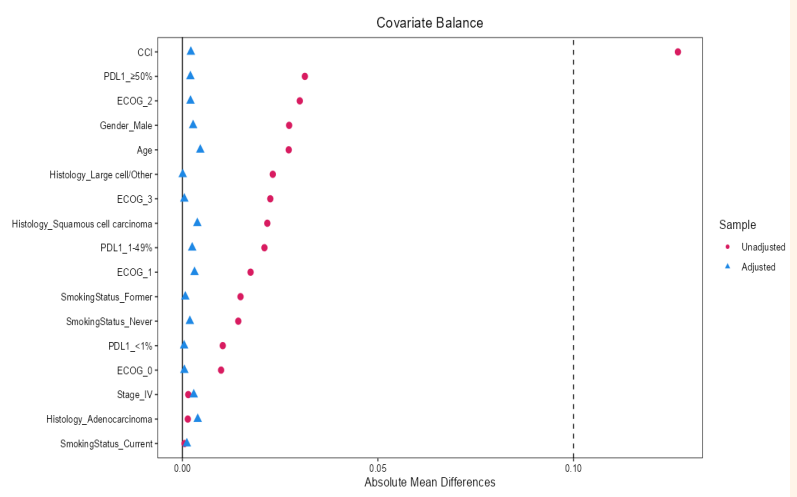
Table versus DV

> The greatest value of a picture is when it forces us to notice what we never expected to see.
>
> — John W. Tukey

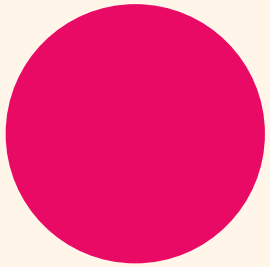
Table

Covariate	Type	Diff.Un	Diff.Adj	M.Threshold
Age	Contin.	-0.0272099342281392 8	-0.00653856954793728 1	Balanced, <0.1
Gender_Male	Binary	0.0273131573479951 1	-0.00206431143886121	Balanced, <0.1
SmokingStatus_Current	Binary	-0.0005720978829367174	-0.00165391269715392 5	Balanced, <0.1
SmokingStatus_Former	Binary	0.0148805670393331 6	0.00009258407667633861	Balanced, <0.1
SmokingStatus_Never	Binary	-0.0143084691563965 1	0.00156132862047754 5	Balanced, <0.1
Histology_Adenocarcinoma	Binary	-0.0014001342924504 5	0.00325695811726012 3	Balanced, <0.1
Histology_Large cell/Other	Binary	0.023130820719578 7	0.00052400341722887 85	Balanced, <0.1
Histology_Squamous cell carcinoma	Binary	-0.0217306864271282 8	-0.00378096153448903 6	Balanced, <0.1
Stage_IV	Binary	-0.0015175649105269 03	-0.00291514756126709 5	Balanced, <0.1
ECOG_0	Binary	-0.0099123485822511 1	-0.00046689647747051 4	Balanced, <0.1

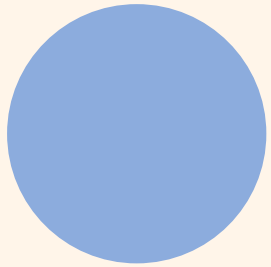
DV



Addressing Limitations of PSM Through Visual Diagnostics



Reveals imbalanced covariates post-matching that may require re-specification.

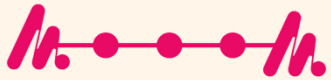


Highlights poor propensity score overlap, reducing the risk of extrapolation bias.

Detects extreme weights in PS weighting that can distort the sample or inflate variance.

Supports sensitivity analyses with visual evidence.

The Role of Advanced Visualization techniques in Enhancing PSM Validity



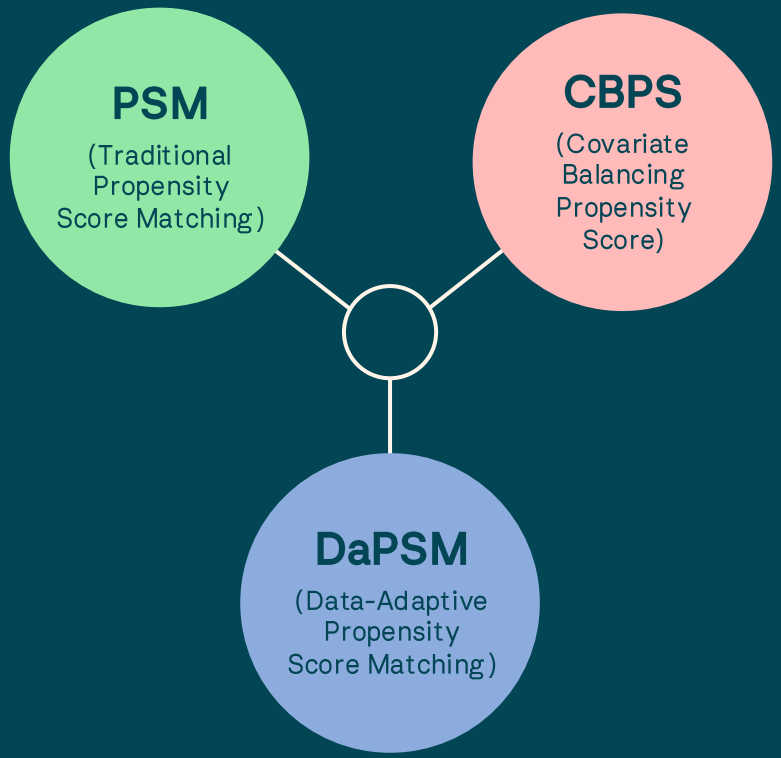
Visualization bridges the gap between statistical outputs and clinical understanding.

Offers a transparent way to evaluate matching quality and model assumptions.

Helps uncover hidden flaws such as poor overlap, imbalance, or overfitting.

Clear communication of complex PSM results to diverse stakeholders through intuitive visual summaries.

PSM Methods and Techniques



Techniques

Nearest Neighbour matching

Each treated unit is matched with a control unit having the closest propensity score. Focuses on similarity in treatment probability based on characteristics

Caliper Matching

A stricter version of NNM. Matches are accepted only if the propensity score difference is within a predefined threshold (caliper).

Inverse probability of treatment weightage

Uses weights instead of matching. Treated units are weighted by 1 / propensity score (PS). Control units are weighted by 1 / (1 – PS).

Case study: PSM Advanced Visualizations

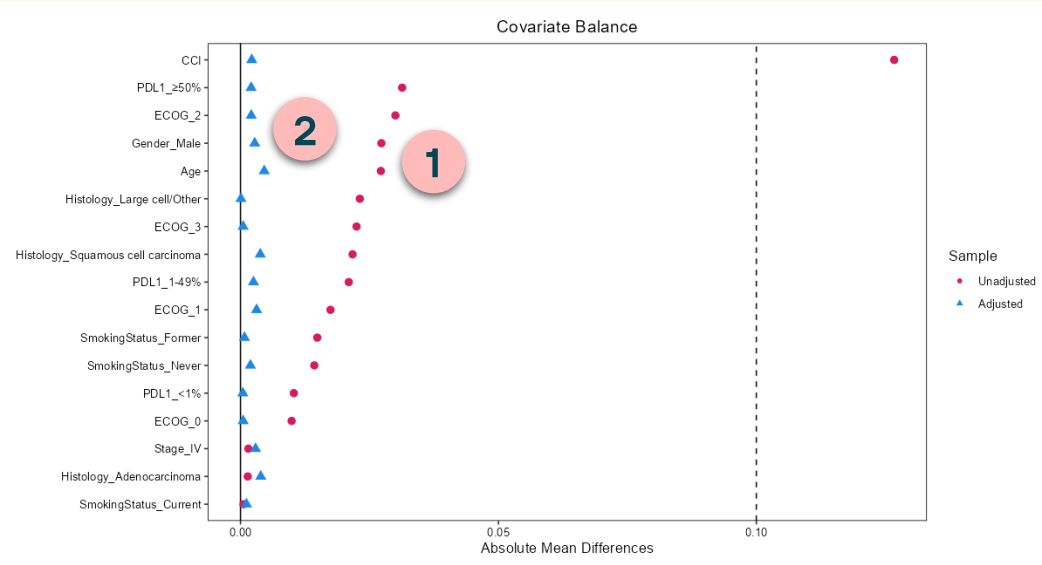
Dashboard Walkthrough

PSM Dashboard

1. Overview and Data (Preview) tabs showing all the plots that we have produced and original data collected.
2. PSM method selection area with radio buttons, which lets us to select the method using which we want to run our model.
3. These are list of all the possible covariates; we can include all or exclude and run the model.
4. Plot area, where we can see the plots generated.
5. Run button to run the selected model.
6. Table showing treatment share percentages of each group
7. Calculated Mean PFS (in Months) for each treatment post weighting

PSM Interpretation with Advance Visualizations

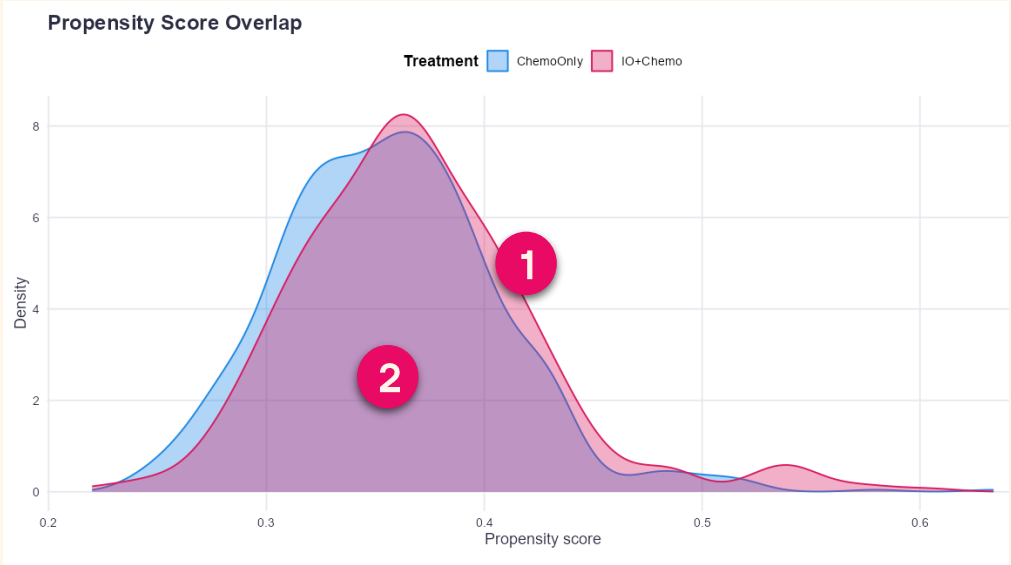
Covariate Balance Plot



1. Large absolute mean differences before weighting

2. Adjusted mean differences after weighting

Propensity Score Overlap

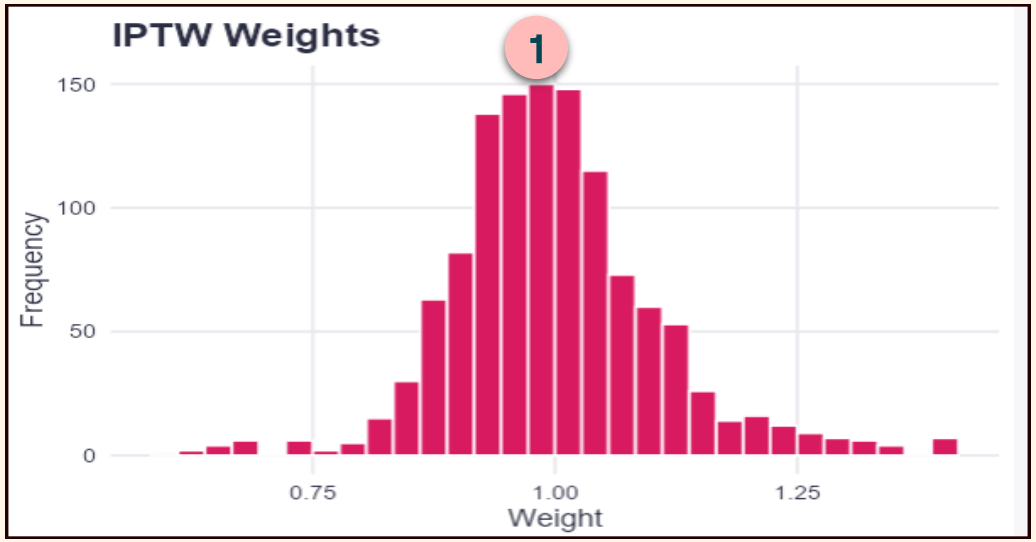


1. Distribution of propensity scores.

2. Good overlap = Effective & Comparable mapping

PSM Interpretation with Advance Visualizations

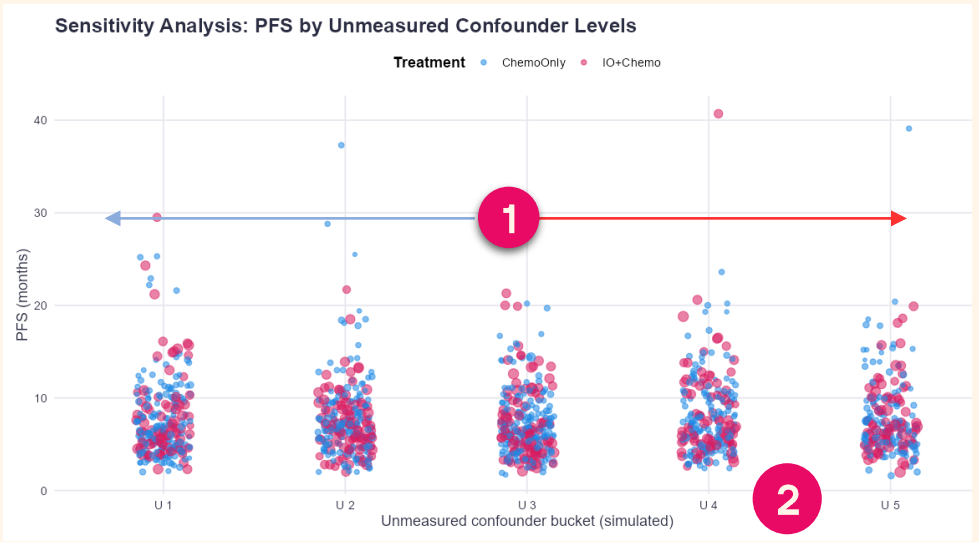
Weight Diagnostic Plot



1

A narrow, centered distribution of weights is always desired and ideal.

Sensitivity Analysis Plot (Rosenbaum Bounds plot)



1

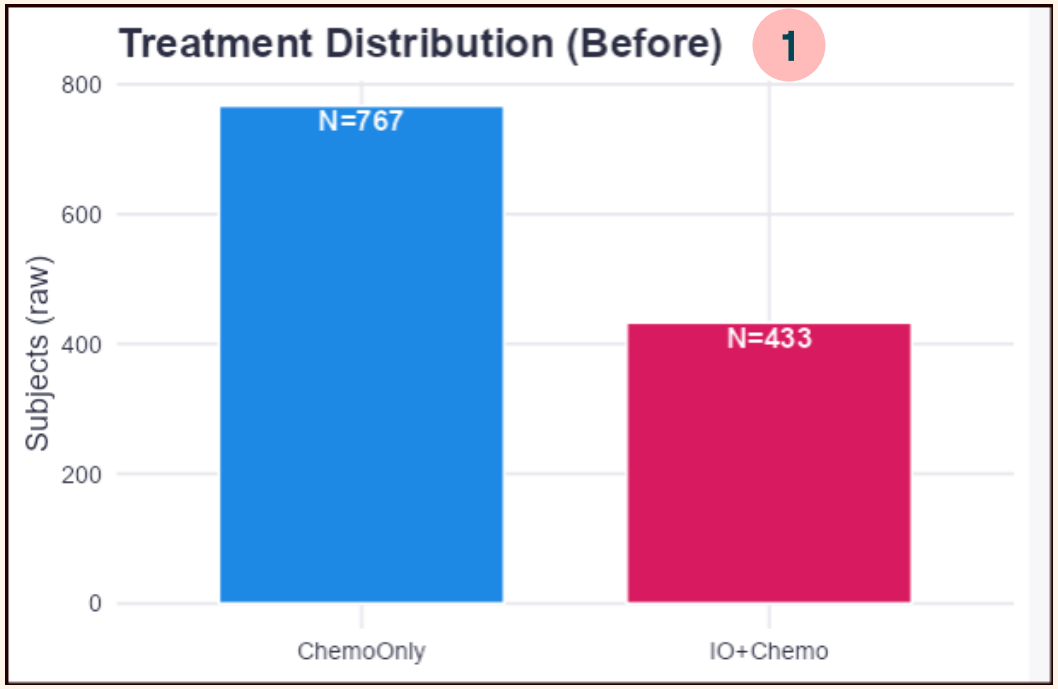
Stable treatment effect/outcome (PFS) with changes in the strength/level of simulated unmeasured confounder.

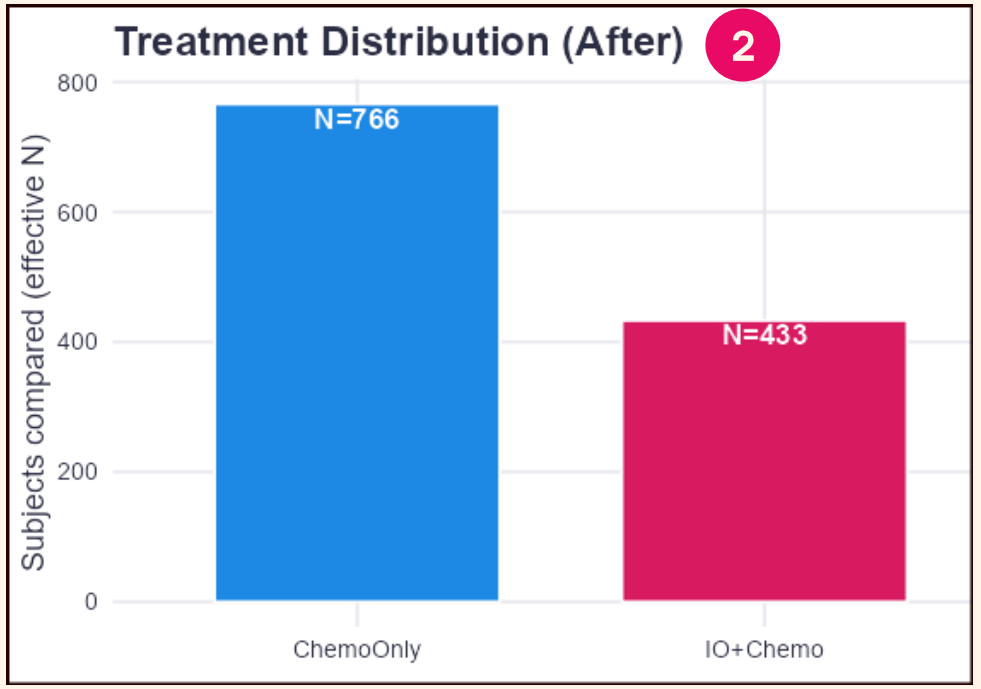
2

Levels of simulated unmeasured confounders on the Y axis.

PSM Interpretation with Advance Visualizations

Treatment Group Distribution





1

Before Weighting: 767 ChemoOnly and 433 IO+Chemo subjects, unequal group sizes, common in real-world data.

2

After Weighting: We nearly retained sample size as per expectation. This is because weighting does not discard subjects; it re-weighs them.

Outcomes

- Diagnostic accuracy
- Early detection of misinterpretation or overlooked bias
- Streamlined process of model refinement and validation.
- Simplified and Accessible to non-statisticians
- Stakeholder Confidence and Communication
- Transparency & Confidence in Evidence Quality
- Proactive decision-making

Conclusion and Future Directions

- Simplified black-box statistical procedure
- Regulatory-grade Evidence quality
- Stake holder Collaboration
- Machine learning–enhanced PSM models
- Integrated Regulatory-focused visual diagnostics into PSM workflows
- Tools for identifying unmeasured confounding analysis

Thank you

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