



WASHINGTON STATE UNIVERSITY  
College of Pharmacy and  
Pharmaceutical Sciences



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# Quantification of Outcome Misclassification



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# Study Overview

## Phase 3

### Correction

Correct outcome misclassification to improve study accuracy

## Phase 2

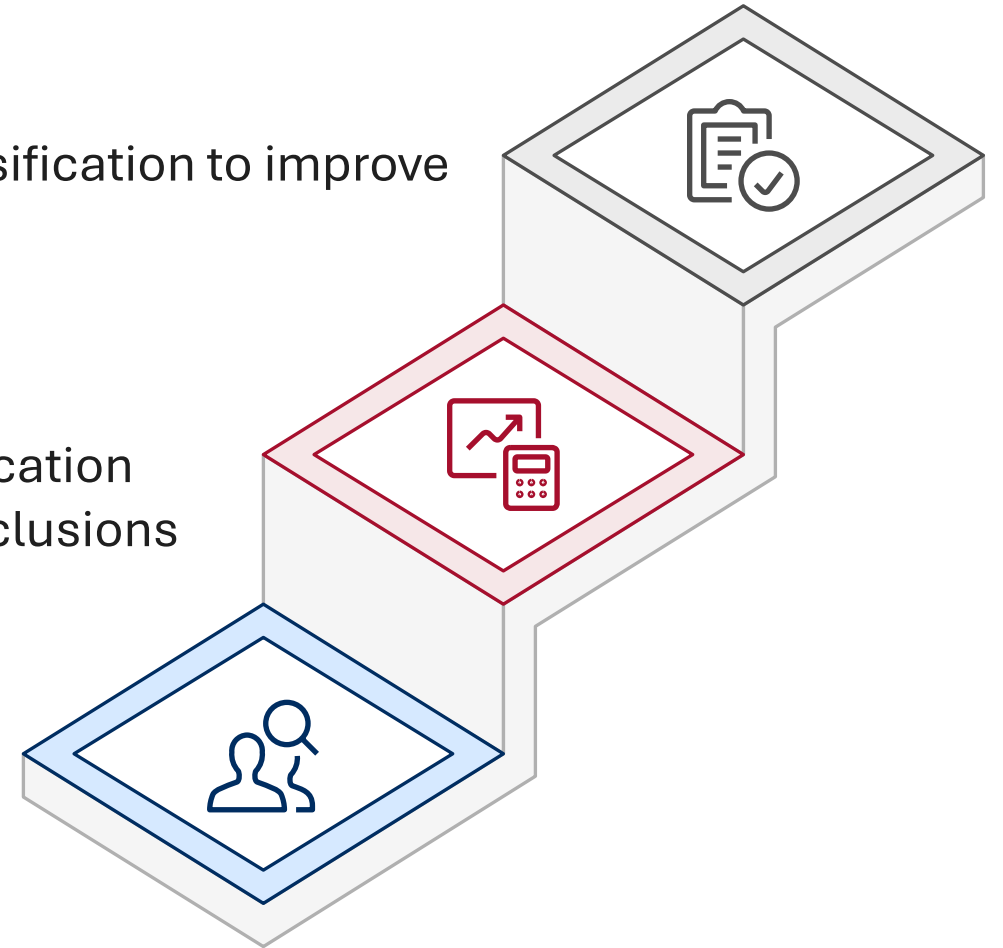
### Impact

Quantify how outcome misclassification impact epidemiological study conclusions

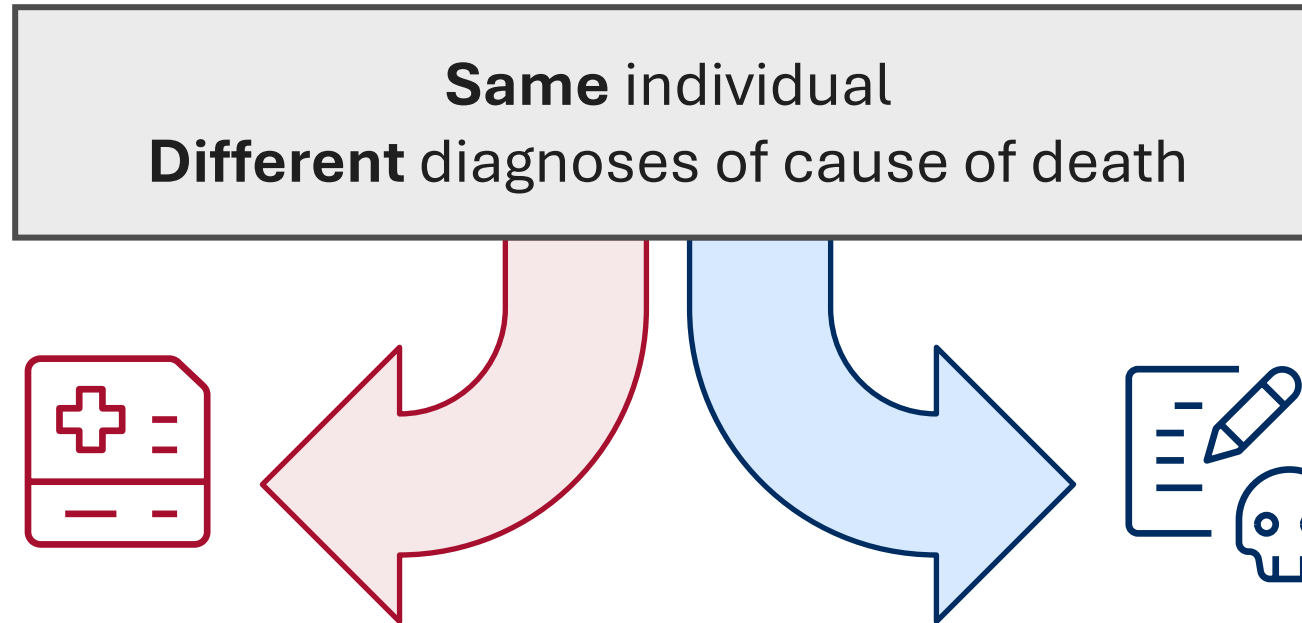
## Phase 1

### Identification

Identify outcome misclassification among USTUR registrants



# Phase 1: Identification



## Death Certificate

- Based on clinical symptoms
- Commonly used in epidemiological studies

## Autopsy Report

- Based on postmortem findings
- Considered the gold standard for underlying cause of death

# Phase 1: Published Findings

**PLOS One** Publish About Browse Search advanced search

OPEN ACCESS PEER-REVIEWED RESEARCH ARTICLE

## Misclassification of causes of death among a small all-autopsied group of former nuclear workers: Death certificates vs. autopsy reports

Stacey L. McComish, Xirui Liu, Florencio T. Martinez, Joey Y. Zhou, Sergey Y. Tolmachev  
 Published: May 3, 2024 • <https://doi.org/10.1371/journal.pone.0302069>

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 1,150 View 0 Share

ICD-10 Chapters	<i>n</i> <sup>b</sup>	Matches	Over-	Under-
2 Neoplasms	80	72 (90.0%)	8 (4.3%)	11 (13.3%)
6 Nervous system	15	10 (66.7%)	5 (2.0%)	3 (23.1%)
9 Circulatory	108	90 (83.3%)	18 (12.2%)	31 (25.6%)
10 Respiratory	26	10 (38.5%)	16 (6.4%)	9 (47.4%)
20 External causes	15	12 (80.0%)	3 (1.2%)	1 (7.7%)
Other	24	6 (25.0%)	n/a	n/a
All Causes	268	200 (74.6%)	n/a	n/a

<sup>a</sup>Number of false positives and false negatives, with the corresponding over- and under-classification rates in parentheses.

<sup>b</sup>Number of death certificates with UCODs in each chapter.

# Phase 2: Research Question

**Quantify outcome misclassification impact on epidemiology study conclusion**

# Phase 2: Study Design

Quantify outcome misclassification impact on epidemiology study conclusions

## Quantify

- Maximum possible impact start from boundary scenario measure percentage

## Outcome misclassification

- Over misclassification
- Under misclassification
- Combined effects

## Impact

- Odds ratio: increase
- $p$ -value: non-significant → significant

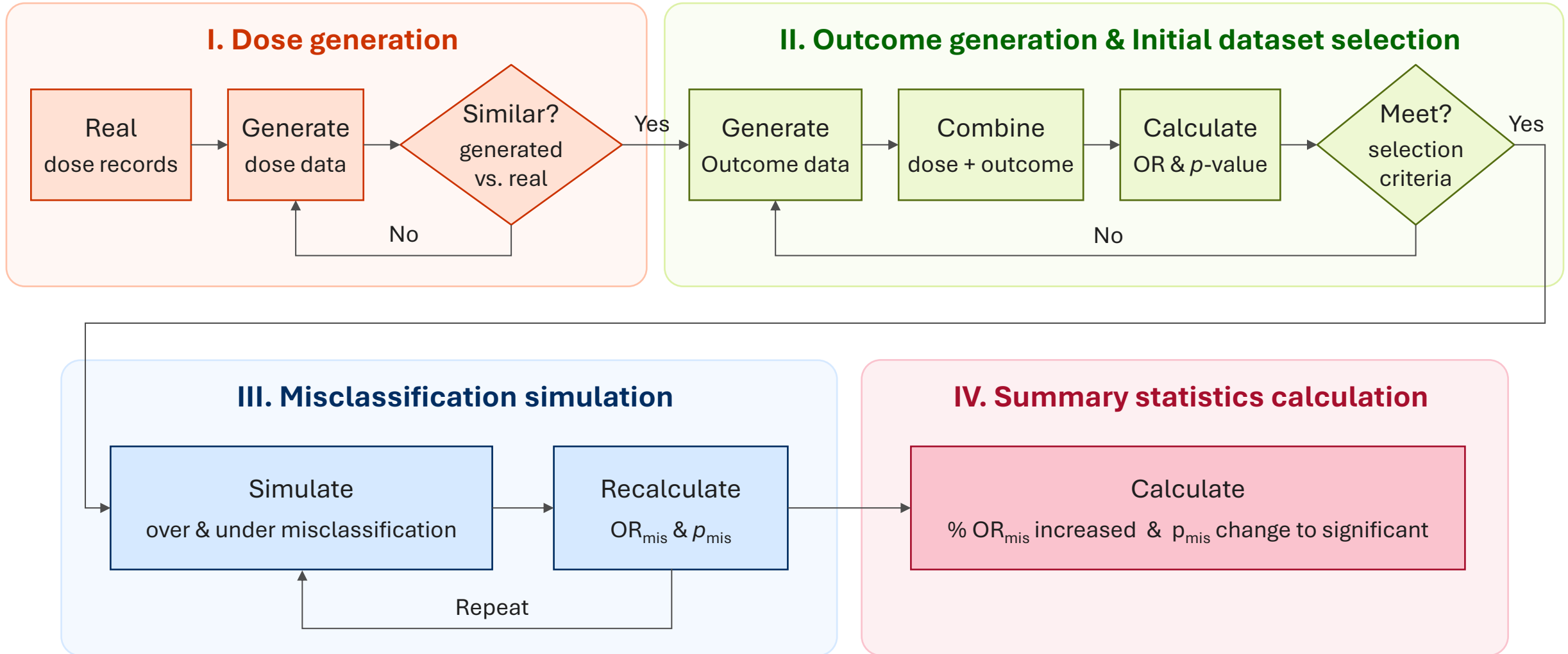
## Epidemiology study

- Independent variable: radiation dose exposure
- Dependent variable: cancer cause of death

## Conclusion

- Odds ratio
- $p$ -value

# Phase 2: Methodology



# R Shiny Tool: Dose Upload and Generation

S:\User Folders\_SYT\SYT\_Xirui\Presentation\2026.04 SAC - Shiny  
http://127.0.0.1:6102 | Open in Browser | Publish

## 1. Dose Upload and Generation

Upload Dose Data (.csv)

Browse...  Upload complete

Upload complete

Show Imported Dose Distribution

Sample Size:

Number of Iterations for Dose:

Minimum Dose Value:

Maximum Dose Value:

Dose generation finished  
[3s] at 2026-03-31 11:08:40

Generate Dose Data

Show Generated Dose Distribution

Compare Imported vs Generated Doses

Download Generated Dose Data

## 2. Outcome Generation

Number of Iterations for Outcome:

### Distribution of Imported Dose Data (N = 300)

Density

Dose (Sv)

Min = 0.00  
Max = 0.71  
Median = 0.08  
GM = 0.07  
GSD = 4.20

### Distribution of Generated Dose Data (N = 500)

Density

Dose (Sv)

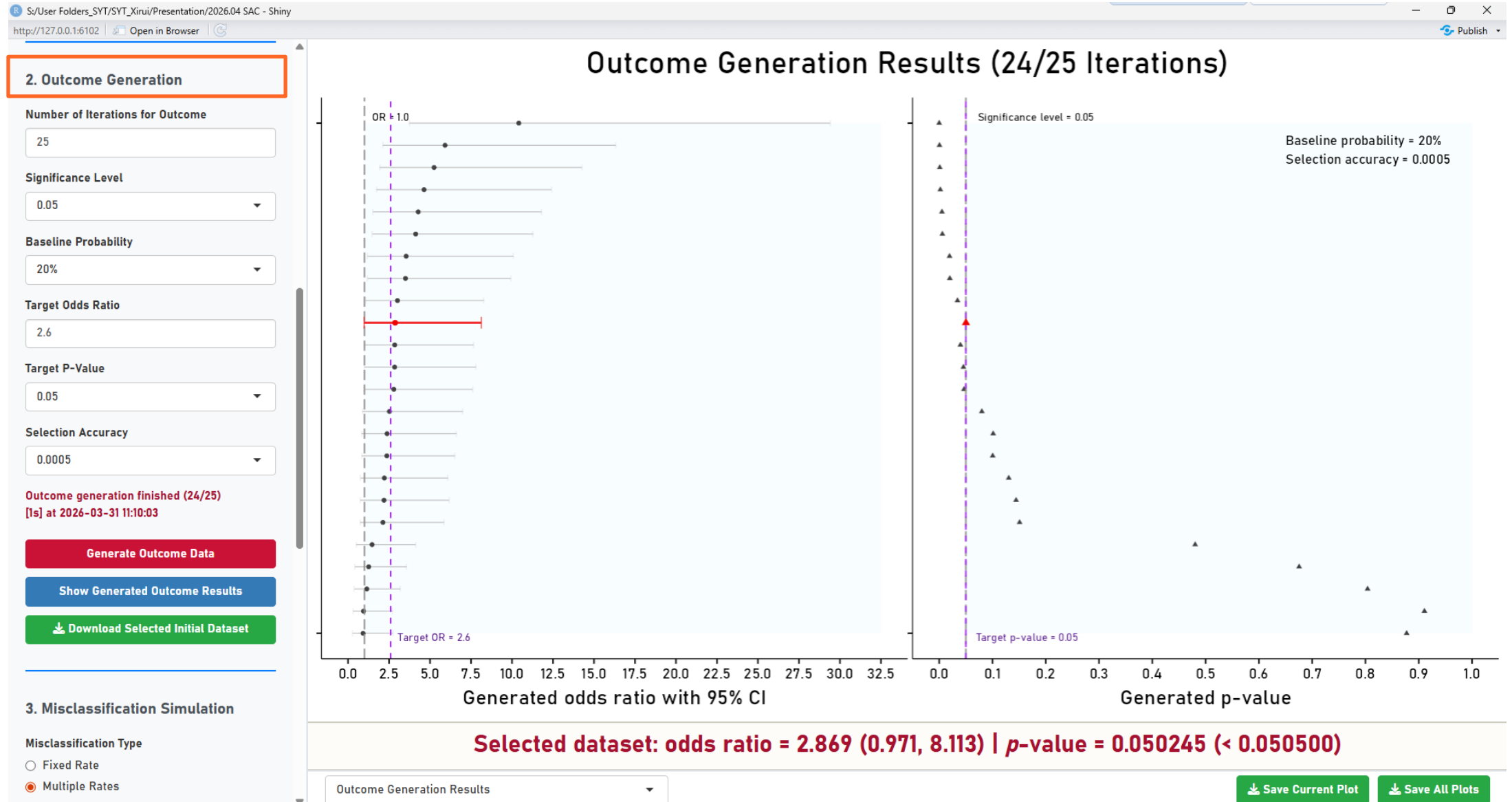
Min = 0.00  
Max = 1.00  
Median = 0.07  
GM = 0.07  
GSD = 4.20  
(Iteration = 20,000)

Dose Distribution Comparison

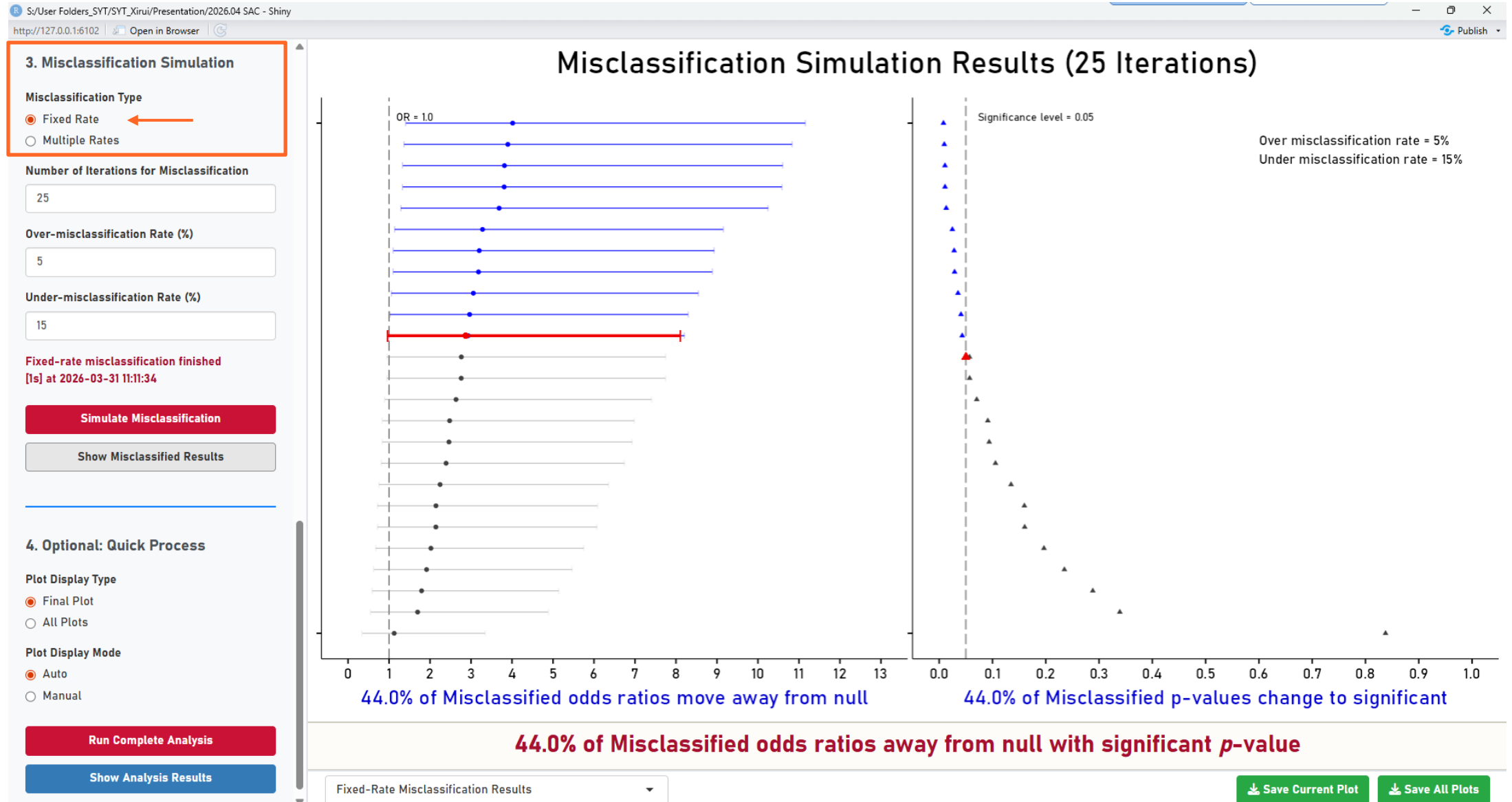
Save Current Plot Save All Plots



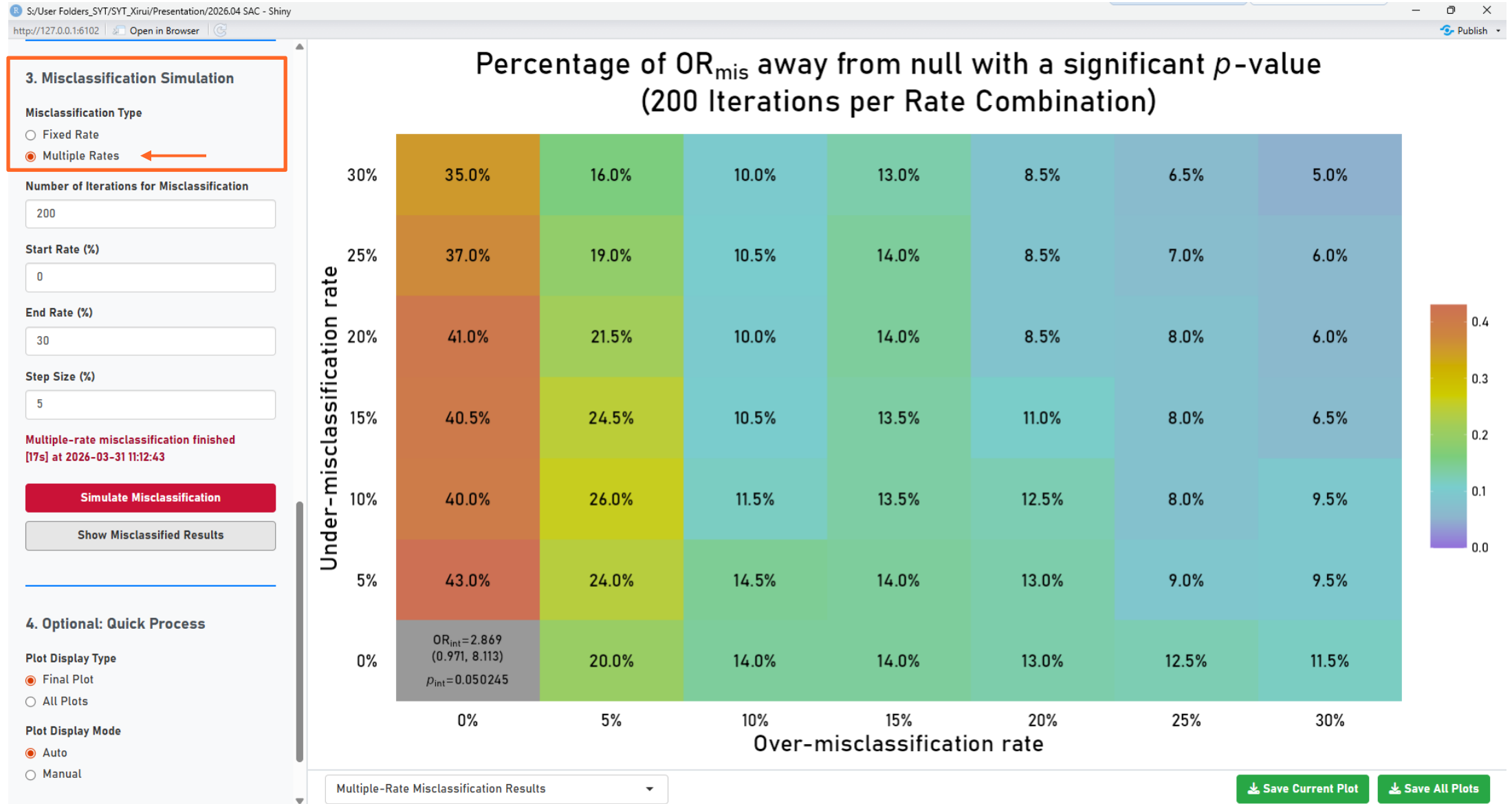
# R Shiny Tool: Outcome Generation and Selection



# R Shiny Tool: Misclassification Simulation



# R Shiny Tool: Statistic Calculation



# Phase 2: Published Findings

## General understanding

- Non-differential misclassification biases dose-response association **toward the null**

## Our finding

- **Non-trivial probability** that outcome misclassification moves an individual dose-response association **away from the null**
  - even changing conclusions **from non-significant to significant**
- In **borderline scenarios**, up to **42.8%** of conclusions could potentially be impacted by the outcome misclassification
- Impact was **more sensitive to low misclassification rates**

### scientific reports

Article | [Open access](#) | Published: 04 March 2026

#### **Inference under outcome misclassification in health risk models using a simulation study with a validation dataset**

[Xirui Liu](#) , [Stacey L. McComish](#), [Sara C. Howard](#), [Joey Y. Zhou](#) & [Sergey Y. Tolmachev](#)

[Scientific Reports](#), Article number: (2026) | [Cite this article](#)

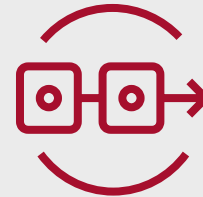


# Phase 2: Factor Analysis



## Sample Size

200 → 5,000



## Number of simulations

50 → 5,000



## Disease baseline probability

10% → 20% → 30%



## Significance threshold

0.01 → 0.05 → 0.10

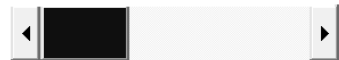


# Phase 2 Factor: Sample Size

## Parameter Setting

I. Generate dose

Sample size: 200



II. Generate outcome

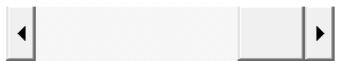
Disease baseline: 20%



Sig threshold: 0.05

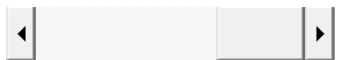


Accuracy: 0.000005



III. Simulate misclassification

Iteration times: 5,000



## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)

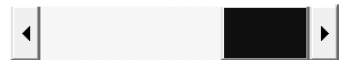


# Phase 2 Factor: Sample Size

## Parameter Setting

I. Generate dose

Sample size: 5,000



II. Generate outcome

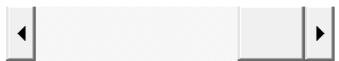
Disease baseline: 20%



Sig threshold: 0.05

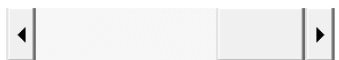


Accuracy: 0.000005



III. Simulate misclassification

Iteration times: 5,000



## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)

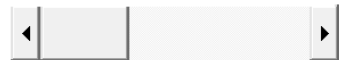


# Phase 2 Factor: Number of Simulations

## Parameter Setting

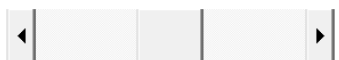
### I. Generate dose

Sample size: 500



### II. Generate outcome

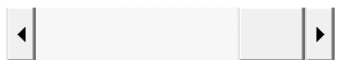
Disease baseline: 20%



Sig threshold: 0.05

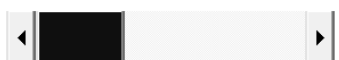


Accuracy: 0.000005



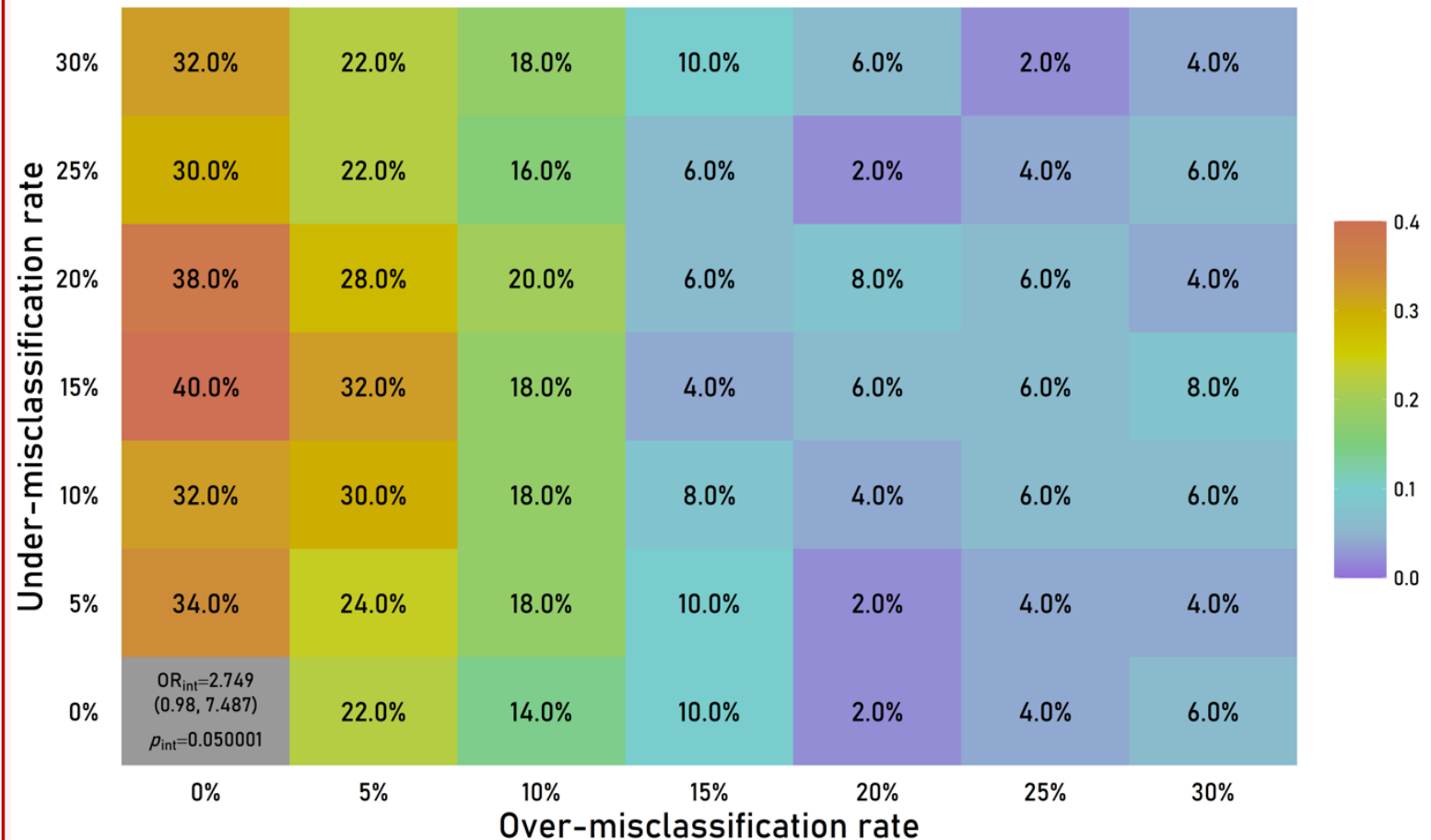
### III. Simulate misclassification

Iteration times: 50



## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(50 Iterations per Rate Combination)

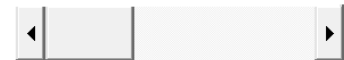


# Phase 2 Factor: Number of Simulations

## Parameter Setting

### I. Generate dose

Sample size: 500



### II. Generate outcome

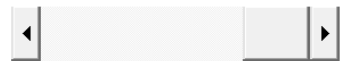
Disease baseline: 20%



Sig threshold: 0.05

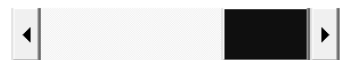


Accuracy: 0.000005



### III. Simulate misclassification

Iteration times: 5,000



## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)



# Phase 2 Factor: Baseline Disease Probability

## Parameter Setting

### I. Generate dose

Sample size: 5,000

### II. Generate outcome

Disease baseline: 10%

Sig threshold: 0.01

Accuracy: 0.000005

### III. Simulate misclassification

Iteration times: 5,000

## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)



# Phase 2 Factor: Baseline Disease Probability

## Parameter Setting

### I. Generate dose

Sample size: 5,000

### II. Generate outcome

Disease baseline: 30%

Sig threshold: 0.01

Accuracy: 0.000005

### III. Simulate misclassification

Iteration times: 5,000

## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)



# Phase 2 Factor: Significance Threshold

## Parameter Setting

### I. Generate dose

Sample size: 5,000

### II. Generate outcome

Disease baseline: 10%

Sig threshold: 0.01

Accuracy: 0.000005

### III. Simulate misclassification

Iteration times: 5,000

## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)



# Phase 2 Factor: Significance Threshold

## Parameter Setting

### I. Generate dose

Sample size: 5,000

### II. Generate outcome

Disease baseline: 10%

Sig threshold: 0.10

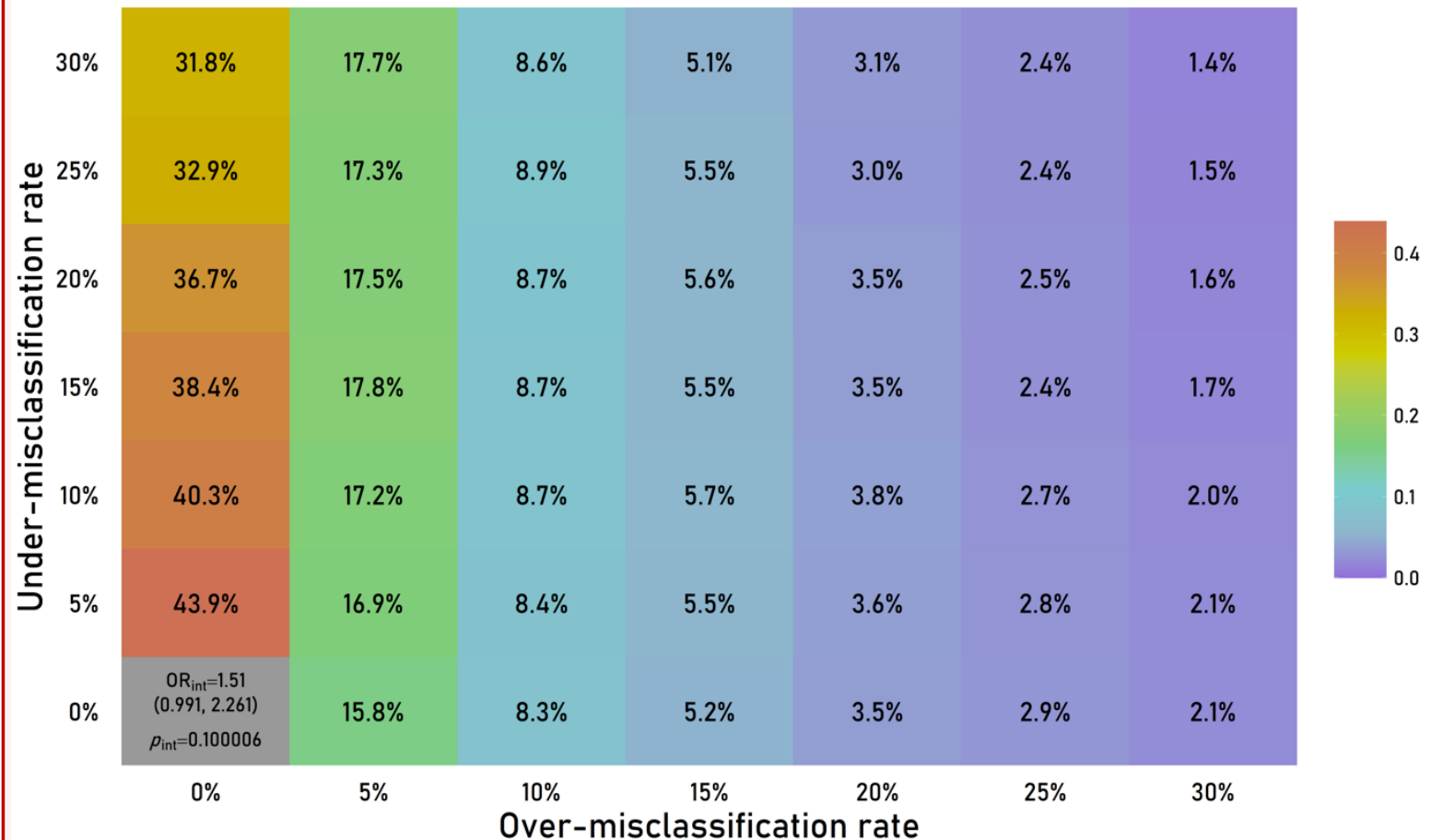
Accuracy: 0.000005

### III. Simulate misclassification

Iteration times: 5,000

## Heatmap Results

Percentage of  $OR_{mis}$  away from null with a significant  $p$ -value  
(5,000 Iterations per Rate Combination)



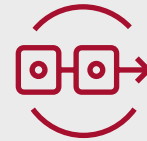
# Phase 2: Factor Analysis



## Sample Size

200 → 5,000

Initial dataset easier to find and more practically representative



## Number of simulations

50 → 5,000

Pattern smoother, cleaner, and more interpretable



## Disease baseline probability

10% → 20% → 30%

Higher percentage decreases  
Lower percentage increases



## Significance threshold

0.01 → 0.05 → 0.10

Percentages increase across all combinations of rates



# Summary and Future Work



## Phase 2 Impact

- Quantify the misclassification impact on epidemiological study
- Explore factors affect the results



## Phase 3 Correction

- Apply correction methods
- Assess whether correction methods work as expected



**Thank you! :)**