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Abstract

Motivation: The opioid epidemic has been a longstanding issue in the United States where almost 1.5 million individuals were diagnosed with opioid use disorder (OUD) in 2022 alone. Opioid use disorder patients are also vulnerable to using other substances, which may create additional challenges in treating their OUD conditions. Therefore, it is necessary that researchers identify challenges that impact OUD treatment rates so that medical professionals can formulate effective treatment strategies for their patients.

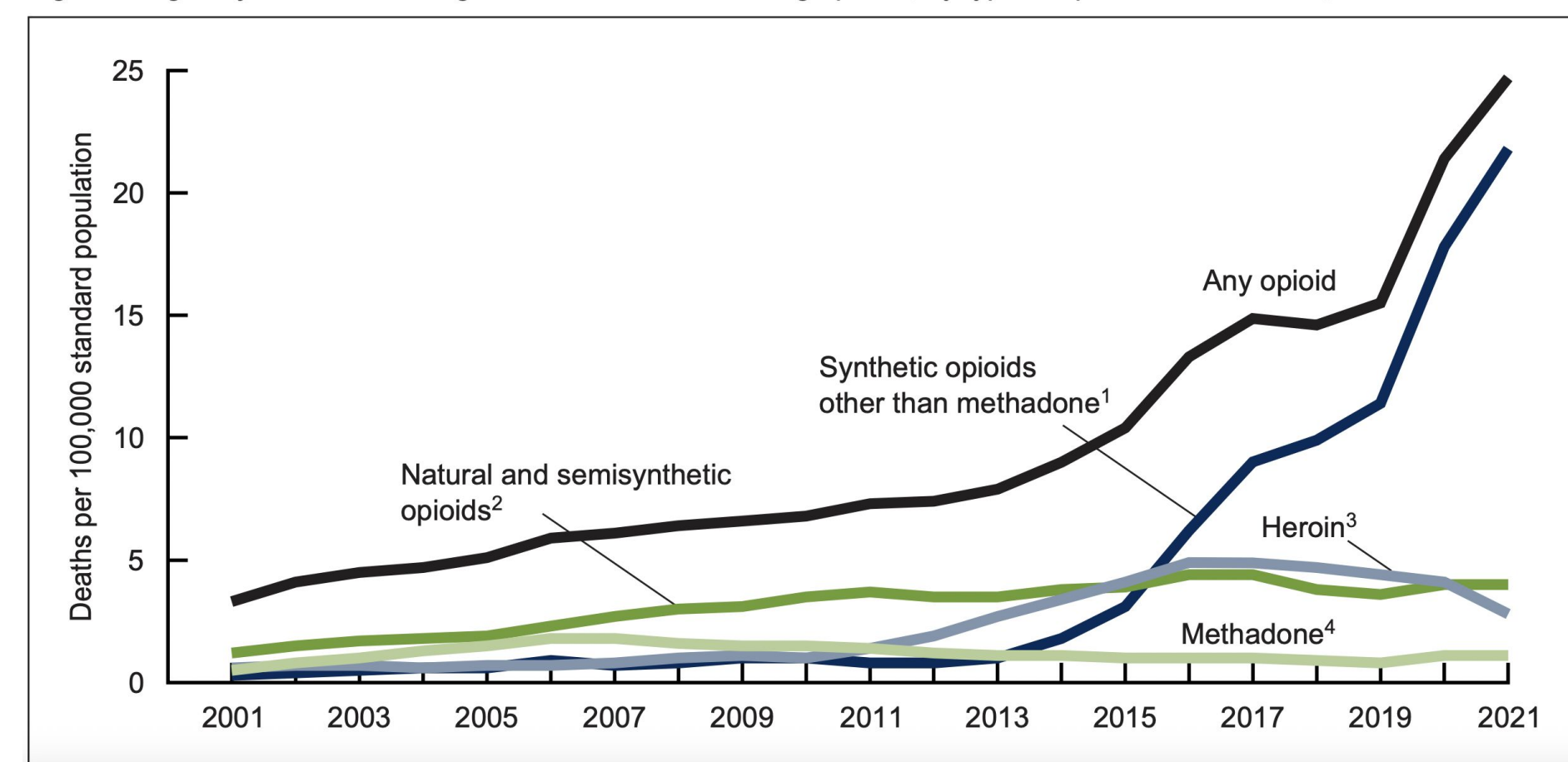
Personal Objectives: Through data science techniques, our goal is to understand how to efficiently analyze our dataset and discover factors that impact OUD treatment rates. Such findings can be useful to the public and policymakers since they raise awareness about the consequences of opioid and cocaine use.

Results: Individuals who use cocaine as a secondary use to their primary opioid use are less likely to complete rehabilitation treatment compared to patients who do not use different substances secondarily.

Background

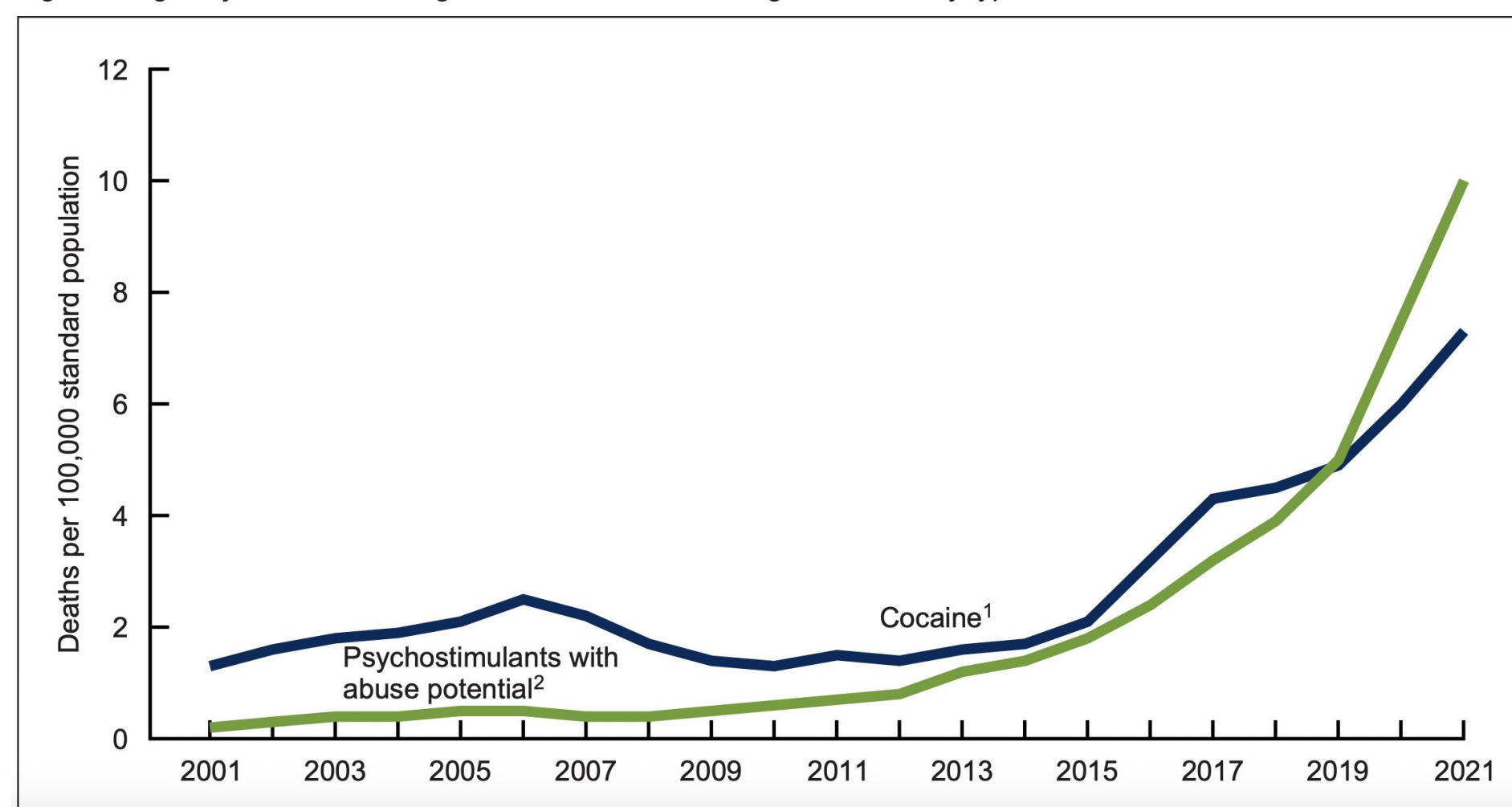
While opioids can be a useful treatment for many types of pain because they trigger the body to release endorphins around the brain, this exact effect can be very addictive to patients. This impact is still prevalent today where an increasing number of individuals have died from opioid overdoses.

Figure 4. Age-adjusted rate of drug overdose deaths involving opioids, by type of opioid: United States, 2001–2021



Unlike opioids, cocaine is classified as a stimulant however it too can be a very addictive substance through the increase in dopamine levels.

Figure 5. Age-adjusted rate of drug overdose deaths involving stimulants, by type of stimulant: United States, 2001–2021



*Source: Spencer, M. R., Miniño, A. M., & Warner, M. (2022, December). Drug overdose deaths in the United States, 2001–2021 (NCHS Data Brief No. 457). National Center for Health Statistics.

Cocaine as a Secondary Substance: Effects on Rehab Completion in Opioid Users

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Experimental Methods

Data Preprocessing

- Clean dataset, remove values with 20% or more missing data for each individual
- Transform data to binary code
- Organize secondary use categories
- Drop columns such as ID, YEAR, and Crack/Cocaine reported at admission

Logistic Regression

- 80% train, 20% test
- Compute residuals squared
- Retrieve propensity score
- Top 5 coefficients & T-test

$$\text{Propensity Score Formula}$$
$$p = \frac{1}{1 + \exp(-X\beta)}$$

Calculate Inverse Probability Weighted Treatment (IPTW)

- Use the inverse of the propensity scores to assign weights
- Individuals with atypical characteristics for the outcome receive more weight
- Mimics randomness
- Balances the treated and untreated groups
- Limits impact of confounders

Confidence Interval (CI)

- Calculated standard error of ATT distribution
- Built 95% confidence interval using percentile method
- Lower and upper bounds reflect estimation precision

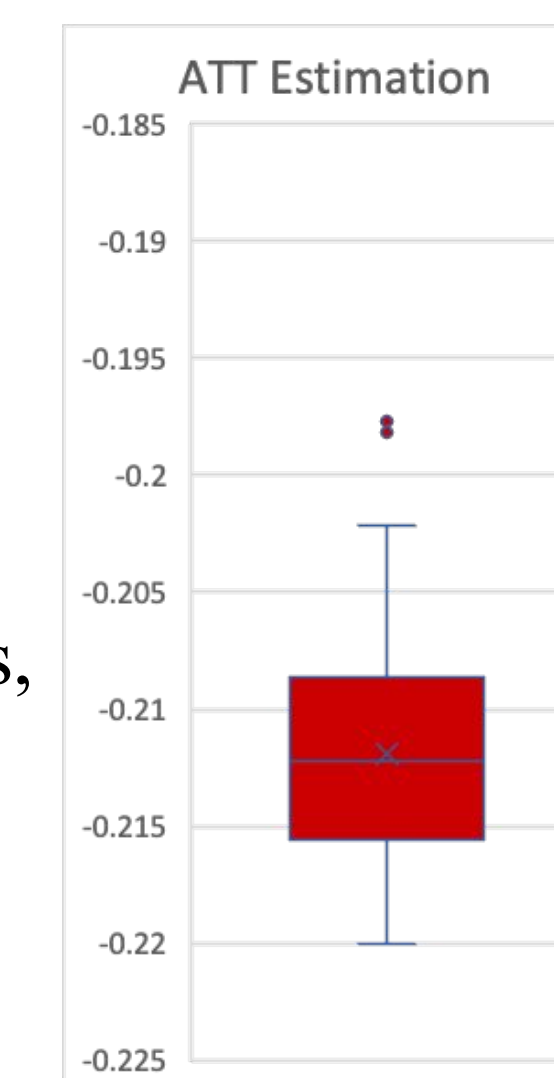
Z-test

- Tested if ATT is statistically significantly < 0
 - Null hypothesis (H_0):
 - ATT = 0 (no effect)
 - Alternative hypothesis (H_1):
 - ATT < 0 (negative effect)
- Used Z-score formula to compute p-value

$$Z \text{ score} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}}$$

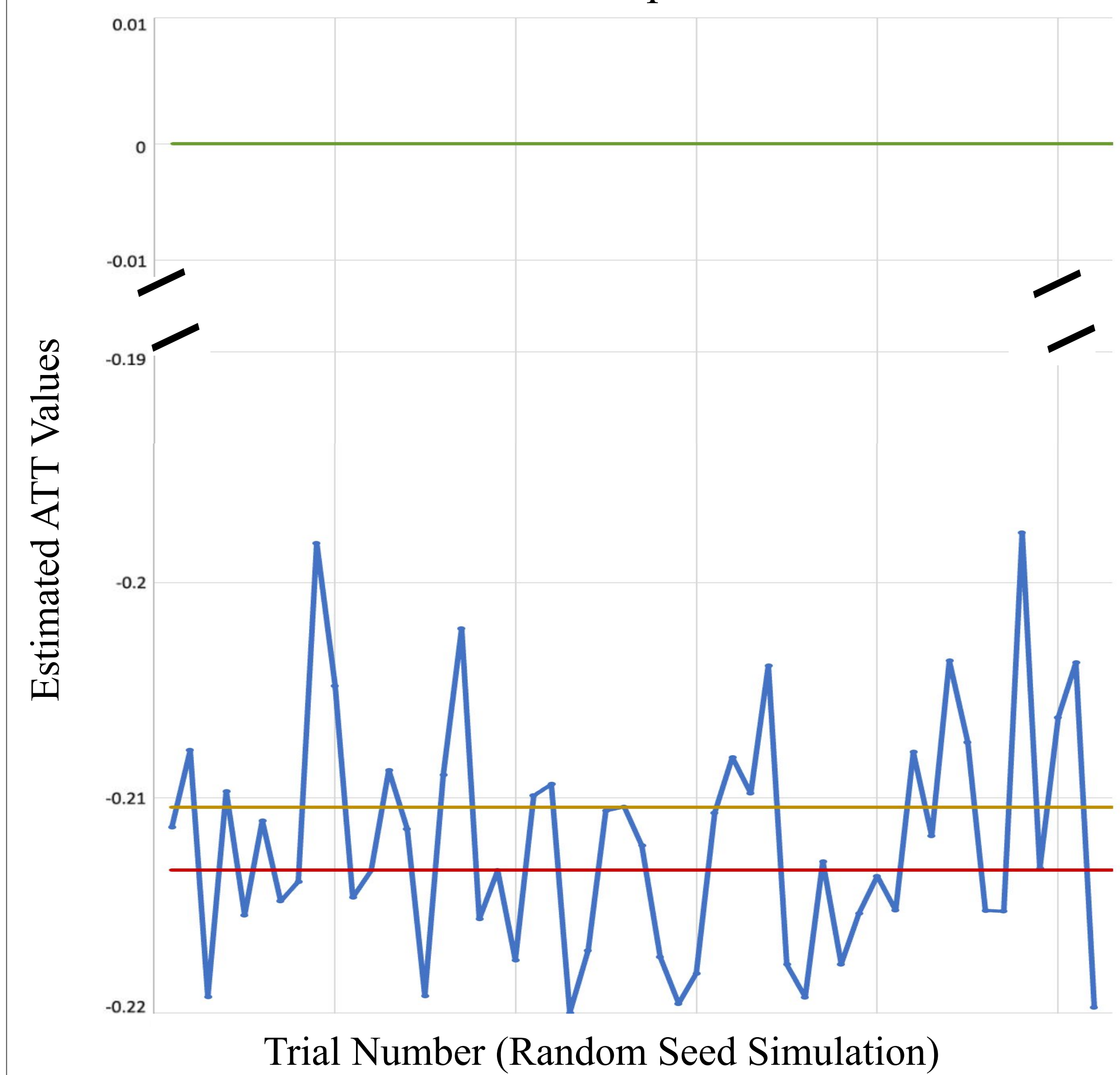
Calculate the Average Treatment effect on the Treated (ATT)

- Compute pairwise treatment effects
- Estimate ATT
- Assess sampling variability & build the ATT distribution
- Run 53 random trials, find ATT



Results

IPTW ATT Over 53 Train/Test Splits for Cocaine as SUB2



- Line - CI Lower Bound: [-0.2134]
- Line - CI Upper Bound: [-0.2104]
- Line - Each ATT Trial
- Line - H_0

- The boxplot of ATT estimates shows low variability, indicating a stable treatment effect
- Z-score = -283.309
- P-value from Z-Test ~ 0
- CI does not include 0

Findings

There is statistically significant evidence that the true ATT is negative

Conclusion and Future Steps

The study confirms that individuals who use cocaine secondarily to opioids tend to have lower chances to complete rehabilitation than individuals who only use opioids. If medical professionals have access to the differences in success rates between users, they can generate specialized treatment strategies so each individual can have the best chance at rehabilitation. Therefore, one helpful further step in this process would be to investigate the effect of other substances use and share the outcome to create awareness. Medical professionals and policymakers could design new strategies and campaign for addiction recovery.

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