Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_ Class: \_\_\_\_\_\_\_\_\_\_\_\_

**Difference-in-Differences Workshop**

This workshop uses simulated data based on a real study testing the effectiveness of a Tool on surgical safety, measured by NOTECHS score. Code for this workshop is available for SAS, Stata, and R software. These can be downloaded from h**ttps://github.com/eleanormurray/DiD\_Tutorial**.

Note: Remember that since the data in this workshop is synthetic, any conclusions drawn from the following analyses should not be taken as evidence for or against real world causal effects.

1. **Getting to know the data**

Run Code Section 0: Data set up & formatting. If using SAS Studio, it might make sense to omit the optional lines of code in this section pertaining to style. Running the format code from lines 9-27 of the ‘tutorial\_style\_template.sas’ is important, though, before running the main difference-in-differences code. Answer the following questions based on your output from Section 0.

**Question 1.1**

How many surgical observations (n) are in the did\_sim data set?

**Question 1.2**

How many variables are in the did\_sim data set?

**Question 1.3**

How many surgeries occurred before introduction of the Tool (DBT)? How many surgeries occurred in the post-intervention time period?

**Question 1.4**

In this study, departments were assigned to either a control group or a treatment group where surgeons were offered the Tool to use. How many surgical observations are in each treatment group?

1. **Causal Assumptions**

There are three major causal assumptions that must be met before drawing causal interpretations from the difference-in-differences analyses. Run Code Section 1: Checking Assumptions. Answer the following questions based on the output and assumptions laid out in the source paper.

**Question 2.1**

In the context of this study design, what is the causal question?

**Question 2.2**

The means procedure is performed to assess the average NOTECHS score in the control and intervention departments at both the pre- and post-COVID baseline time periods. Compare these outcome values.

**Question 2.3**

What is the pre-intervention trend difference (control and intervention departments) in NOTECHS score? Provide 95% confidence limits and the standard error. The pre-intervention trend difference provides support for which causal assumption?

**Exercise 2.4**

Briefly describe the positivity assumption in the context of the study.

1. **Crude Analyses**

Run Code Section 2: Unadjusted models. Two different linear regression models are created, one excluding the pre-COVID data and one using the full data set, and a Poisson regression is also modeled. Answer the following questions based on the source paper and output from only the regression models which include the full data set.

**Exercise 3.1**

Draw a directed acyclic graph (DAG) of the assumed data structure including the following variables: Pre-COVID Baseline (Yt=-12), Baseline (Yt=0), Z, Change in NOTECHS Score, Device Type, Case Complexity, and Department.

**Exercise 3.2**

Provide the regression equation for the unadjusted linear model using parameter estimates β and the notation from Box 1. Which parameter can be used to calculate the difference-in differences estimator?

**Exercise 3.3**

Fill in the table below with the predicted values and difference-in-differences estimator from the unadjusted linear regression model. Here, it will be helpful to run Optional Code 2.2.2.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Post-COVID Baseline | Post-Intervention | *Row differences* |
| Intervention |  |  |  |
| Control |  |  |  |
| *Column Differences* |  |  | DiD = |

**Question 3.4**

What effect does the Tool have, if any, on average NOTECHS score in the intervention group? Report on the significance of the difference-in-differences estimate.

**Exercise 3.5**

Provide the regression equation for the unadjusted Poisson model using parameter estimates α and the notation from Box 1.

**Exercise 3.6**

Fill in the table below with the predicted values and difference-in-differences estimator from the unadjusted Poisson regression model.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Post-COVID Baseline | Post-Intervention | *Row differences* |
| Intervention |  |  |  |
| Control |  |  |  |
| *Column Differences* |  |  | DiD = |

**Question 3.7**

How do the results from the unadjusted linear and Poisson models compare?

1. **Adjusted Analyses**

Run Code Section 3: Adjusted Linear Models. Answer the following questions based on the source paper and your output.

**Question 4.1**

Which of the variables in the DAG should be adjusted for as confounders? Why?

**Exercise 4.2**

Provide the regression equation for the adjusted linear model using parameter estimates γ and the notation from Box 1.

**Question 4.3**

What is the mean conditional difference-in-differences estimate? Provide 95% confidence limits and the standard error.

**Question 4.4**

The first step in adjusting for confounders required using a multivariable regression model conditional on confounder levels. However, the unconditional effects may be of greater interest in this analysis. What is the name of the process used to estimate these unconditional (marginal) effects after adjustment? Why is this process considered a necessary step in the adjusted analysis?

**Exercise 4.5**

Fill in the table below with the predicted values and unconditional (marginal) difference-in-differences estimator from the adjusted linear regression model. Here, it will be helpful to run Optional Code 3.2.2.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Post-COVID Baseline | Post-Intervention | *Row differences* |
| Intervention |  |  |  |
| Control |  |  |  |
| *Column Differences* |  |  | DiD|L = |

**Question 4.6**

What effect does the Tool have, if any, on average NOTECHS score in the intervention group, after adjusting for confounders?

**Question 4.7**

How do the crude and adjusted difference-in-differences analyses compare? What conclusions can be drawn about the Tool regarding surgical safety?