You're the Epidemiologist

Design, Run & Analyze Your Own Outbreak Experiment

FOLLOW-UP INVESTIGATION • Use your testable question from the previous VaxImpact worksheet. • Suitable for middle & high school inquiry.

Part I — Build Your Experiment

1. Copy or refine the testable question you developed in the earlier lesson. It should change only one simulator input and measure an outbreak outcome. Ex. How does Vaccination rate influence disease transmission and outbreak size?

My testable question:

2. Identify your variables and write a prediction.

Independent variable (what I change)	Primary dependent variable (what I measure)

A Hypothesis is the Actual Prediction. Example: If vaccination rate increases, then disease transmission will decrease and the number of total and peak infections will also decrease. This is because there will be less susceptible individuals in the community to contract the infectious disease and spread it to other individuals in the community.

3. Choose ALL simulator settings. Create three conditions (A, B, C). Change **ONE** input across the conditions and keep the other five exactly the same. The changed input will be the Independent or Manipulated Variable.

Simulator input (circle ONE to change)	Condition A	Condition B	Condition C
Transmission rate (%)			
Infectious period (days)			
Mortality rate (%)			
Population density (%)			
Vaccine effectiveness (%)			
Vaccination rate (%)			

Each condition uses 5 new simulation runs. Your chosen independent variable should have three different values (one in each column). Check the simulator's allowed ranges before starting.

MODEL REMINDER This is a teaching model of a simulated community. Results describe the simulator under your chosen settings—not real-world vaccine targets or medical recommendations.

Part II — Carry Out the Experiment

Run each condition FIVE times (15 runs total). For every trial, start a fresh simulation, leave all non-tested settings unchanged, and wait until the run has ended before recording the same primary outcome.

Record Raw results for each trial—not just the average. Your statistics calculator will need all 15 measurements. **Be sure to include units when listing the independent and dependent variables.**

Condition A | Independent-variable setting: _____

Trial	Dependent Variable #1: _____	Dependent Variable #2 _____	Dependent Variable #3 (Optional) _____	Dependent Variable #4 (Optional) _____
1				
2				
3				
4				
5				
Mean				

Condition B | Independent-variable setting: _____

Trial	Dependent Variable #1: _____	Dependent Variable #2 _____	Dependent Variable #3 (Optional) _____	Dependent Variable #4 (Optional) _____
1				
2				
3				
4				
5				
Mean				

Condition C | Independent-variable setting: _____

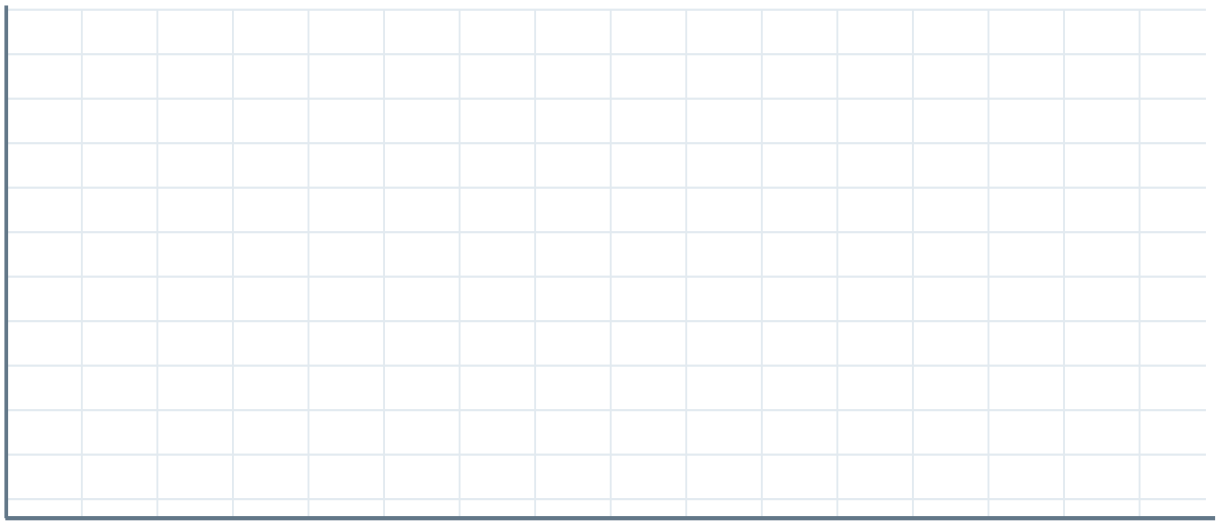
Trial	Dependent Variable #1: _____	Dependent Variable #2 _____	Dependent Variable #3 (Optional) _____	Dependent Variable #4 (Optional) _____
1				
2				
3				
4				
5				
Mean				

NOTE: If you track more than one outcome/dependent variable, analyze it separately; Do NOT combine different measures in one ANOVA.

Part III — Visualize and Test Your Data

1. Graph One of the outcomes/dependent variables you measured for Conditions A, B, and C. Label the x-axis with the three independent-variable settings, the y-axis with the outcome and units, and give the graph a descriptive title.

Title:_____



2. Write a Null and Alternative Hypothesis:

When scientists conduct an experiment, they often develop TWO hypotheses to help determine whether changing a variable has a measurable effect.

Null Hypothesis (H_0): States that changing the independent variable will have **NO Effect** on the dependent variable. Any differences observed between experimental groups are assumed to be due to random variation or chance. Example: Changing the vaccination rate does not affect the average total number of infections during an outbreak.

Write your Null Hypothesis here: _____

_____

Alternative Hypothesis (H_1): States that changing the independent variable **DOES have an effect** on the dependent variable. Example: Changing the vaccination rate affects the average total number of infections during an outbreak.

Write your Alternative Hypothesis here: _____

_____

3. Test for differences among the three conditions using a One-Way ANOVA and Tukey's HSD pairwise comparisons.

FREE STATISTICS TOOL: ToolMug One-Way ANOVA + Tukey HSD Calculator

1. Paste the FIVE raw primary-outcome values from A in column 1, B in column 2, and C in column 3.
2. Find the one-way ANOVA p-value. If $p < 0.05$, the result is statistically significant: differences this large would be unlikely from random variation alone if all group means were truly equal.
3. Read Tukey's HSD table and use its ADJUSTED p-values to see which pairs (A–B, A–C, B–C) differ.
4. If $p \geq 0.05$, there is insufficient evidence to claim that there is a difference between the two conditions. Note, this is NOT proof that the conditions are identical.

ANOVA compares all three condition means overall. Tukey's test then checks specific pairs while accounting for multiple comparisons.

STATISTICS CHECK This is an introductory analysis. One-way ANOVA/Tukey assume independent runs, roughly normal outcomes within each condition, and similar variation across conditions. With only five trials and possible all-zero outcomes, interpret results cautiously.

Part IV — Interpret, Explain & Evaluate

1. Record the statistical results for your PRIMARY outcome.

One-way ANOVA p-value	Statistically significant? ($p < 0.05$)
	Yes or No: _____

NOTE: If the ANOVA's p-value is greater than 0.05, then a Tukey's HSD pairwise is not necessary. This is because the Tukey pairwise step allows us to see which conditions are statistically significant from one another, which is irrelevant if the p-value from ANOVA is greater than 0.05 (since this indicates there is no difference between ANY of the conditions). Regardless of your ANOVA results today, we will be looking at the Tukey HSD pairwise values for practice.

Tukey comparison	Adjusted p-value	Significant? ($p < 0.05$)
A vs. B		Yes / No
A vs. C		Yes / No
B vs. C		Yes / No

2. Based on your results, do you reject the Null Hypothesis? Note: You do not accept a null hypothesis. You either reject or fail to reject.

_____

_____

3. Explain your results using Claim–Evidence–Reasoning (CER). Address whether the evidence supports your original prediction.

CLAIM Answer your testable question. Describe the pattern across A, B, and C.

EVIDENCE Give at least two actual group averages and the ANOVA/Tukey p-value(s).

REASONING Explain how the changed input could affect your measured outcome, and connect your data to your claim.

4. Evaluate the investigation (short answers).

MODEL LIMITATION: Identify one real-world factor that VaxImpact simplifies or omits. How might it change your results?

STATISTICAL LIMITATION: What is one limitation of using five trials per condition or of the ANOVA assumptions? What would you improve?

Resources & method references: VaxShield simulator (vaxshield.org); ToolMug One-Way ANOVA Calculator (hcju.com/anova-calculator); Penn State STAT 500, Lesson 10 (online.stat.psu.edu/stat500/Lesson10); GraphPad statistics guide (graphpad.com).