

WS #4 - efficacy

Math 150, Jo Hardin

Monday, February 2, 2026

Your Name: _____

Names of people you worked with: _____

Is 85° F a good temperature for January?

Task: Consider the following data which are taken from <https://www.nytimes.com/2020/12/13/learning/what-does-95-effective-mean-teaching-the-math-of-vaccine-efficacy.html>. The data are originally from the Pfizer study <https://www.nytimes.com/2020/11/covid-vaccine.html>.

Group	Group Size	Number Infected
Placebo	21,830	162
Vaccine	21,830	8

1. Using the data above, calculate \widehat{RR} , \widehat{OR} , and efficacy.
2. What is the difference (in words) between efficacy and effectiveness?

Solution:

$$\begin{aligned}\widehat{RR} &= \frac{162/21830}{8/21830} = 20.25 \\ \widehat{OR} &= \frac{162/21668}{8/21822} = 20.39 \\ \text{efficacy} &= \frac{162/21830 - 8/21830}{162/21830} = 0.95\end{aligned}$$

Efficacy is the value calculated from the data collected by the study (the number calculated above). Effectiveness is the actual relative risk reduction (of vaccine over placebo) in the entire population. You can think of efficacy as the performance under ideal conditions and effectiveness as the performance under real-world conditions. Note that we want to understand effectiveness (the **parameter**) but we can only measure the efficacy (the **statistic**).

Some real-world difference (between the sample and the population) that might impact the vaccine's performance include:

- The population being fundamentally different from the sample (i.e., who was it that volunteered for the study? were they more generally healthy? did they have better access to health care?)
- Who is giving the vaccine? Is there some mechanism by which the original trained doctors give the vaccine that will be difficult to replicate in the mass roll out of the vaccine world-wide?
- What happens if people only get one dose? Will we try to measure the performance of the drug? Do those cases get included in effectiveness?
- What other interventions are being used? What if people in the larger population get shots from two different vaccines? Or modify behavior / treatment in other ways (which are different from those individuals in the sample)?