Instructions

Upload your solutions (handwritten or typed) via Canvas Assignments on or before 10/12/2021.

Grading scheme

a	b	c	d	e	f	g	h	Total
2	2	2	3	3	2	3	3	20

Clinical trials. Vaccine development is a long, complex process. In the European Union, the European Medicines Agency supervises regulation of vaccines and other drugs. The development and testing of a vaccine follows a standard set of steps. The first step is includes laboratory development and animal studies. A candidate vaccine that performs well in this step advances to clinical trials with human subjects.
During Phase I of the clinical trials a small group of healthy adults (aged 20-50, with no underlying medical conditions) receive the vaccine. The goals are to assess the safety of the candidate vaccine and to determine the type and extent of immune response that the vaccine provokes.
A regulating agency considers the results of a Phase I clinical trial as "safe" whenever none of the subjects show severe side effects, and the proportion of subjects with mild to moderate side effects is smaller than 30% at a significance level of 0.05.

Suppose a group of researchers carry out a Phase I trial for a candidate vaccine, and observe that out of a group of 25 volunteers none shows severe side effects and only 5 subject presented moderate side effects. Will the regulating agency authorize the candidate vaccine to advance into Phase II clinical trials?

In order to answer the question, the researchers perform a binomial test with significance level $\alpha_0 = 5\%$ and determine whether the population proportion of people who would have mild to moderate side effects is smaller than 30%.

a. State carefully the probability model involved, make sure to define all your variables and explain which parameters are known and which unknown.

b. Which type of test should they perform? A two-sided test, a left-sided test, or a right-sided test? State the null and alternative hypotheses.

c. Define the test statistic, justify your choice. Now give the distribution of it under the null hypothesis.

d. Define the rejection region using a critical value.

e. What is the P-value of the result?

f. Explain in words the conclusion that can be drawn from this clinical trial.

g. Compute the power of the test, assuming the true proportion is $p = 0.2$. What could the researchers do to increase the power of the test?

h. After the trial is concluded, the researchers noticed that 5 out of the 25 subjects involved are members of the same family. The researchers have different opinions about how to react to this fact.

- Researcher 1 thinks there is no reason to revise the results in **f.**

- Researcher 2 thinks that the 5 family members should be dropped from the trial, and the data should be re-analized using only the remaining 20 subjects.
- Researcher 3 thinks that the integrity of the trial is compromised and they need to start all over again.

For each of the 3 opinions above, judge whether the statement is valid from a statistical perspective. What would you advise the researchers to do (and why)?

Do's and Do not's when planning an experiment

👍 Always exercise caution and be critical (but remember we never have absolute certainty)

👍 Pay attention to how your data is collected. Can it really be considered a random sample?

👍 Choose your sample size based on the effect size you want to be able to detect (eg. in terms of the power of the test)

👍 Ask someone or look for online help when in doubt

👎 Don't apply a model without checking that the assumptions are satisfied!

👎 Don't fall into the trap of thinking that the answer of a bad model is better than no answer at all!