Investigation Chapter 5: Does Vitamin C improve your health?

In 1970 Linus Pauling, a well-known chemist and Nobel Prize winning scientist, published *Vitamin C and the Common Cold* (1970) creating a great deal of public and scientific interest. In short, Pauling argued that taking Vitamin C would reduce one's risk of the common cold. This book almost singlehandedly made Vitamin C one of the most widely used dietary supplements, a status it retains to this day (Nutritional Supplement Review, 2009). Subsequent to the publishing of his book, Pauling wrote a paper that appeared in the Proceedings of the National Academy of Sciences in 1971. In this paper he describes a study conducted by a physician in Basel, Switzerland in the early 1960s.

Here is an excerpt from the paper explaining the study design:

"The study was carried out in a ski resort with 279 skiers during two periods of 5-7 days. The conditions were such that the incidence of colds during these short periods was large enough (about 20%) to permit results with statistical significance to be obtained. The subjects were roughly of the same age and had similar nutrition during the period of study. The investigation was double-blind, with neither the participants nor the physicians having any knowledge about the distribution of the ascorbic-acid tablets (1000 mg) and the placebo tablets. The tablets were distributed every morning and taken by the subjects under observation, so that the possibility of interchange of tablets was eliminated. The subjects were examined daily for symptoms of colds and other infections. The records were largely on the basis of subjective symptoms, partially supported by objective observations (measurement of body temperature, inspection of the respiratory organs, auscultation of the lungs, and so on). Persons who showed cold symptoms on the first day were excluded from the investigation.

After the completion of the investigation, a completely independent group of professional people was provided with the identification numbers for the ascorbic-acid tablets and placebo tablets, and this group performed the statistical evaluation of the observations." **While not stated explicitly in the paragraph above, the participants were randomly assigned to take ascorbic-acid tablets or the placebo.**

Step 1: Ask a research question

1. State the research question.

Step 2: Design a study and collect data

2. Is this study an experiment or an observational study? How are you deciding?

3. What are the observational/experimental units?

4. What are the variables that are measured/recorded on each unit?

5. Describe the parameters of interest in words. (You can use the symbol π to represent these parameters.)

6. State the null and alternative hypotheses for a test of significance to see if this experiment provides statistically significant evidence that Vitamin C prevented colds in the skiers. Use a one-sided test.

7. Of the 139 skiers assigned to take a vitamin C, 17 developed a cold. Of the 140 skiers assigned to take a placebo, 31 developed a cold. Fill in the 2x2 table provided.

	Vitamin C	Placebo	Total
No cold			
Cold			
Total			

8. *Incidence* is the term used to describe the percent of the sample who onset with an illness over a certain time period. In this case, the incidence rates are the same as the conditional proportions. Find the incidence rates for individuals who received Vitamin C and those who received the placebo.

Step 3: Explore the data

9. What is the difference in incidence rates in the two groups? Before doing a test of significance, comment on whether you think this is evidence that Vitamin C prevents colds.

Step 4: Draw inferences

Let's use our 3S strategy to help us investigate how much evidence the sample data provide to support our conjecture that Vitamin C prevents colds.

10. What is the statistic that you can use to summarize the data collected in the study?

11. Use the *Two Proportions* applet to carry out a test of significance.

12. When you shuffle, you are simulating one of the two hypotheses (null or alternative) to be true, which one are you simulating?

13. What is the shape of your null distribution and where is its center located? Why does it make sense for the center to be located where it is?

14. Find the p-value of your test. Is this strong enough evidence for you to conclude that Vitamin C prevented colds in the skiers? Write a sentence stating your conclusion as it applies to the question. Remember to use words pertaining to the research question.

Step 5: Formulate conclusions
15. Can we generalize our conclusion to the entire human population? What should be true of the 279 skiers in order for your conclusion to be drawn to the entire human population? Discuss how the sample was obtained. Are there characteristics about the sample subjects that make this an unreasonable generalization?

16. Can we make a cause and effect conclusion? Why or why not?

Step 6: Look back and ahead
17. Summarize your findings from the study. What did you like about the study design? What would you change to improve the study? What further research might you want to do to follow up or expand upon the results in this study?

There continues to be much controversy regarding the use of Vitamin C both in the prevention of colds and other negative health outcomes. Recently, the Physicians Health Study II was completed. In November 2008, a paper (Sesso et al. 2008) was published in the Journal of the American Medical Association which reported on some of the results of the Physicians Health Study II. Consider the following excerpt from the abstract of the paper:

> *The Physicians' Health Study II was a randomized, double-blind, placebo-controlled…trial of…vitamin C that began in 1997 and continued until its scheduled completion on August 31, 2007. There were 14,641 US male physicians enrolled, who were initially aged 50 years or older.*

18. Explain what it means for the Physicians' Health Study II to be…. (you may need to look some of these terms up outside of our textbook)

   a) …randomized.

   b) …double-blind.

   c) …placebo-controlled.

19. Later in the paper we find out that 619 out of 7329 men who got Vitamin C had a "Major cardiovascular event" compared to 626 out of 7312 men who got the placebo. We also read that the p-value for a *difference* in incidence rates is 0.91. Find the incidence rates, state the null and alternative hypotheses for a test of the effectiveness of Vitamin C draw inferences about the effectiveness of Vitamin C in preventing major cardiovascular events in this sample.

20. In the paper it states that "In this large, long-term trial of male physicians…vitamin C supplementation [did not] reduce the risk of major cardiovascular events. These data provide no support for the use of [vitamin C] for the prevention of cardiovascular disease in middle-aged and older men." Why do you think the authors specifically qualified their conclusion to say "middle-aged and older men?"

Final Comment: There are actually well over 1000 different experiments that have been done on Vitamin C for cold prevention, heart attack prevention and a multitude of other health benefits. The studies reported here are merely two of more well-known studies. Neither study is conclusive, nor is there general consensus in the scientific community as to the health benefits of supplementing your diet with Vitamin C to attain levels beyond the minimal levels necessary to prevent scurvy.