Polio Experiment

In 1954 an experiment was conducted to test the effectiveness of the Salk vaccine as protection against the devastating effects of polio.

Approximately 200,000 children were injected with an ineffective salt solution, and 200,000 other children were injected with the vaccine. The experiment was "double blind" because the children being injected didn't know whether they were given the real vaccine or the placebo, and the doctors giving the injections and evaluating the results didn't know either. Only 33 of the 200,000 vaccinated children later developed paralytic polio, whereas 115 of the 200,000 injected with the salt solution later developed paralytic polio. Statistical analysis of these and other results led to the conclusion that the Salk vaccine was indeed effective against paralytic polio.

Interpretation

We must address the original claim that "money in a large denomination is less likely to be spent relative to an equivalent amount in many smaller denominations." Because we reject the null hypothesis, we conclude that there is sufficient evidence to support the claim that $p_1 < p_2$. That is, there is sufficient evidence to support the claim that people with money in large denominations are less likely to spend relative to people with an equivalent amount of money in smaller denominations. (See Table 8-3 in Section 8-2 for help in wording the final conclusion.) Based on these results, it appears that the original claim is supported.

It should be noted that the study subjects were 89 undergraduate business students from two different colleges. It would be wise to qualify the preceding conclusions by saying that the results do not necessarily apply to the general population.

Critical Value Method of Testing Hypotheses

The critical value method of testing hypotheses can also be used for Example 1. In Step 6, instead of finding the *P*-value, find the critical value. With a significance level of $\alpha = 0.05$ in a left-tailed test based on the normal distribution, we refer to Table A-2 and find that an area of $\alpha = 0.05$ in the left tail corresponds to the critical value of $z = -1.645$. In Figure 9-1(b) we can see that the test statistic of $z = -3.49$ falls within the critical region bounded by the critical value of $z = -1.645$. We again reject the null hypothesis. The conclusions are the same as in Example 1.

Confidence Intervals

Using the format given earlier in this section, we can construct a confidence interval estimate of the difference between population proportions $(p_1 - p_2)$. If a confidence interval estimate of $p_1 - p_2$ does not include 0, we have evidence suggesting that p_1 and p_2 have different values. The confidence interval uses a standard deviation based on estimated values of the population proportions, whereas a hypothesis test uses a standard deviation based on the assumption that the two population proportions are equal. Consequently, a conclusion based on a confidence interval might be different from a conclusion based on a hypothesis test. See the following cautions.

CAUTIONS

1. When testing a claim about two population proportions, the *P*-value method and the critical value method are equivalent, but they are *not* equivalent to the confidence interval method. If you want to test a claim about two population proportions, use the *P*-value method or critical value method; if you want to estimate the difference between two population proportions, use a confidence interval.
2. Don't test for equality of two population proportions by determining whether there is an overlap between two individual confidence interval estimates of the two individual population proportions. When compared to the confidence interval estimate of $p_1 - p_2$, the analysis of overlap between two individual confidence intervals is more conservative (by rejecting equality less often), and it has less power (because it is less likely to reject $p_1 = p_2$ when in reality $p_1 \neq p_2$). (See "On Judging the Significance of Differences by Examining the Overlap Between Confidence Intervals," by Schenker and Gentleman, *American Statistician,* Vol. 55, No. 3.) See Exercise19.