# Chapter Nine

Testing Hypotheses

**Summary**

• Statistical hypothesis testing is a decision-making process that enables us to determine whether a particular sample result falls within a range that can occur by an acceptable level of chance. The process of statistical hypothesis testing consists of five steps: (1) making assumptions, (2) stating the research and null hypotheses and selecting alpha, (3) selecting a sampling distribution and a test statistic, (4) computing the test statistic, and (5) making a decision and interpreting the results.

• Statistical hypothesis testing may involve a comparison between a sample mean and a population mean or a comparison between two sample means. If we know the population variance(s) when testing for differences between means, we can use the Z statistic and the normal distribution. However, in practice, we are unlikely to have this information.

• When testing for differences between means when the population variance(s) are unknown, we use the t statistic and the t distribution.

• Tests involving differences between proportions follow the same procedure as tests for differences between means when population variances are known. The test statistic is Z, and the sampling distribution is approximated by the normal distribution.

**Outline**

* Assumptions of Statistical Hypothesis Testing
  + Level of measurement of the variable
  + The method of sampling
  + The shape of the population distribution
  + Sample size
  + All statistical tests assume random sampling
* Stating the Research and Null Hypotheses
  + The research hypothesis is a statement reflecting the substantive hypothesis; it is always expressed in terms of population parameters, but its specific form varies from test to test
  + The null hypothesis is a statement of “no difference” that contradicts the research hypothesis and is always expressed in terms of population parameters
  + A one-tailed test is a type of hypothesis test that involves a directional research hypothesis; it specifies that the values of one group are either larger or smaller than some specified population value
    - A right-tailed test is a one-tailed test in which the sample outcome is hypothesized to be at the right tail of the sampling distribution
    - A left-tailed test is a one-tailed test in which the sample outcome is hypothesized to be at the left tail of the sampling distribution
  + A two-tailed test is a type of hypothesis test that involves a nondirectional research hypothesis. We are equally interested in whether the values are less than or greater than one another. The sample outcome may be located at both the lower and the higher ends of the sampling distribution
* Determining What Is Sufficiently Improbable: Probability Values and Alpha
  + Z statistic (obtained) is the test statistic computed by converting a sample statistic (such as the mean) to a Z score
  + A P value can be defined as the actual probability associated with the obtained value of Z; it is a measure of how unusual or rare our obtained statistic is compared with what is stated in our null hypothesis
  + Alpha is the level of probability at which the null hypothesis is rejected
    - It is customary to set alpha at the .05, .01, or .001 level
* The Five Steps in Hypothesis Testing: A Summary
  + Making assumptions
  + Stating the research and null hypotheses and selecting alpha
  + Selecting the sampling distribution and specifying the test statistic
  + Computing the test statistic
  + Making a decision and interpreting the results
* Errors in Hypothesis Testing
  + Type I error is the probability associated with rejecting a null hypothesis when it is true
  + Type II error is the probability associated with failing to reject a null hypothesis when it is false
* The *t* Statistic and Estimating the Standard Error
  + The *t* statistic (obtained) is the test statistic computed to test the null hypothesis about a population mean when the population standard deviation is unknown and is estimated using the sample standard deviation
  + The t distribution is a family of curves, each determined by its degrees of freedom
    - Degrees of freedom (df) are the number of scores that are free to vary in calculating a statistic
* Comparing the *t* and Z Statistics
  + Because it is estimated from sample data, the denominator of the t statistic is subject to sampling error.
  + The sampling distribution of the test statistic is not normal, and the standard normal distribution cannot be used to determine probabilities associated with it
* Statistics in Practice
  + The earnings of white women
* Testing Hypotheses About Two Samples
  + Hypothesis testing with two samples follows the same structure as for one-sample tests
  + With a two-sample case, we assume that the samples are independent of each other
  + In one-sample tests, both the null and the research hypotheses are statements about a single population parameter; however, in two-sample tests, we compare two population parameters
* The Sampling Distribution of the Difference Between Means
  + Tests about differences between two sample means are based on the sampling distribution of the difference between means
  + Sampling distribution of the difference between means is a theoretical probability distribution that would be obtained by calculating all the possible mean differences that would be obtained by drawing all the possible independent random samples of size N1 and N2 from two populations where N1 and N2 are both greater than 50
  + The properties of the sampling distribution of the difference between two sample means are determined by a corollary to the central limit theorem
  + Estimating the standard error
  + Calculating the estimated standard error
  + The *t* statistic
  + Calculating the degrees of freedom for a difference between means test
* The Five Steps in Hypothesis Testing About Difference Between Means: A Summary
  + Making assumptions
  + Stating the research and null hypotheses and selecting alpha
  + Selecting the sampling distribution and specifying the test statistic
  + Computing the test statistic
  + Making a decision and interpreting the results
* Focus on Interpretation
  + Cigarette use among teens
* Testing the Significance of the Difference Between Two Sample Proportions
* Statistics in Practice
  + Comparing first and second generation Hispanic Americans
* Focus on Interpretation
  + First and second generation Asian Americans
* Reading the Research Literature
  + Reporting the results of statistical hypothesis testing