

Chapter 400

Tests for One Mean

Introduction

The one-sample t -test is used to test whether the mean of a population is greater than, less than, or not equal to a specific value. Because the t distribution is used to calculate critical values for the test, this test is often called the one-sample t -test. If the standard deviation is known, the normal distribution is used instead of the t distribution and the test is officially known as the z test.

When the data are differences between paired values, this test is known as the *paired t -test*.

This module also calculates the power of the nonparametric analog of the t -test, the *Wilcoxon test*.

Test Procedure

1. **Find the critical value.** Assume that the true mean is M_0 . Choose a value T_α so that the probability of rejecting H_0 when H_0 is true is equal to a specified value called α . Using the t distribution, select T_α so that $\Pr(t > T_\alpha) = \alpha$. This value is found using a t probability table or a computer program (like *PASS*).
2. **Select a sample of n items from the population and compute the t statistic.** Call this value T . If $T > T_\alpha$ reject the null hypothesis that the mean equals M_0 in favor of an alternative hypothesis that the mean equals M_1 where $M_1 > M_0$.

Following is a specific example. Suppose we want to test the hypothesis that a variable, X , has a mean of 100 versus the alternative hypothesis that the mean is greater than 100. Suppose that previous studies have shown that the standard deviation, σ , is 40. A random sample of 100 individuals is used.

We first compute the critical value, T_α . The value of T_α that yields $\alpha = 0.05$ is 106.6. If the mean computed from a sample is greater than 106.6, reject the hypothesis that the mean is 100. Otherwise, do not reject the hypothesis. We call the region greater than 106.6 the *Rejection Region* and values less than or equal to 106.6 the *Acceptance Region* of the significance test.

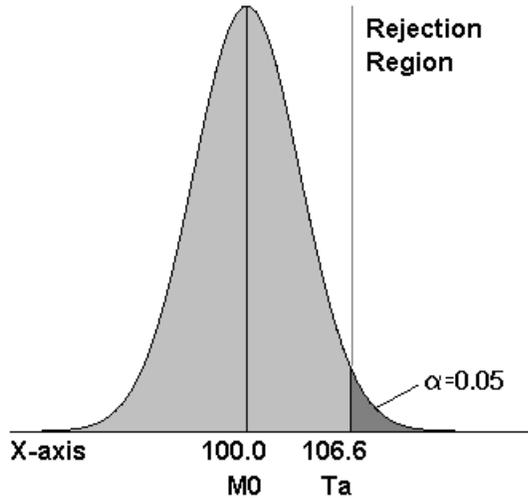
Tests for One Mean

Now suppose that you want to compute the *power* of this testing procedure. In order to compute the power, we must specify an alternative value for the mean.

We decide to compute the power if the true mean were 110. Figure 2 shows how to compute the power in this case.

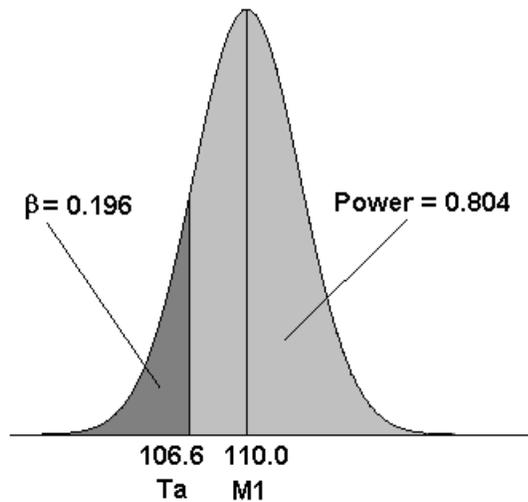
The *power* is the probability of rejecting H_0 when the true mean is 110. Since we reject H_0 when the calculated mean is greater than 106.6, the probability of a Type-II error (called β) is given by the dark, shaded area of the second graph. This value is 0.196. The power is equal to $1 - \beta$ or 0.804.

Figure 1 - Finding Alpha



Note that there are six parameters that may be varied in this situation: two means, standard deviation, alpha, beta, and the sample size.

Figure 2 - Finding Beta



Assumptions

This section describes the assumptions that are made when you use one of these tests. The key assumption relates to normality or non-normality of the data. One of the reasons for the popularity of the t -test is its robustness in the face of assumption violation. However, if an assumption is not met even approximately, the significance levels and the power of the t -test are invalidated. Unfortunately, in practice it often happens that several assumptions are not met. This makes matters even worse! Hence, take the steps to check the assumptions before you make important decisions based on these tests.

One-Sample T-Test Assumptions

The assumptions of the one-sample t -test are:

1. The data are continuous (not discrete).
2. The data follow the normal probability distribution.
3. The sample is a simple random sample from its population. Each individual in the population has an equal probability of being selected in the sample.

Paired T-Test Assumptions

The assumptions of the paired t -test are:

1. The data are continuous (not discrete).
2. The data, i.e., the differences for the matched-pairs, follow a normal probability distribution.
3. The sample of pairs is a simple random sample from its population. Each individual in the population has an equal probability of being selected in the sample.

Wilcoxon Signed-Rank Test Assumptions

The assumptions of the Wilcoxon signed-rank test are as follows (note that the difference is between a data value and the hypothesized median or between the two data values of a pair):

1. The differences are continuous (not discrete).
2. The distribution of each difference is symmetric.
3. The differences are mutually independent.
4. The differences all have the same median.
5. The measurement scale is at least interval.

Limitations

There are few limitations when using these tests. Sample sizes may range from a few to several hundred. If your data are discrete with at least five unique values, you can often ignore the continuous variable assumption. Perhaps the greatest restriction is that your data come from a random sample of the population. If you do not have a random sample, your significance levels will probably be incorrect.

Technical Details

Standard Deviation Known

When the standard deviation is known, the power is calculated as follows for a directional alternative (one-tailed test) in which $MI > MO$.

1. Find z_α such that $1 - \Phi(z_\alpha) = \alpha$, where $\Phi(x)$ is the area under the standardized normal curve to the left of x .
2. Calculate: $X_a = MO + z_\alpha \frac{\sigma}{\sqrt{n}}$.
3. Calculate: $z_a = \frac{X_a - MI}{\frac{\sigma}{\sqrt{n}}}$.
4. Power = $1 - \Phi(z_a)$.

Standard Deviation Unknown

When the standard deviation is unknown, the power is calculated as follows for a directional alternative (one-tailed test) in which $MI > MO$.

1. Find t_α such that $1 - T_{df}(t_\alpha) = \alpha$, where $T_{df}(t_\alpha)$ is the area under a central- t curve to the left of x and $df = n - 1$.
2. Calculate: $x_a = MO + t_\alpha \frac{\sigma}{\sqrt{n}}$.
3. Calculate the noncentrality parameter: $\lambda = \frac{MI - MO}{\frac{\sigma}{\sqrt{n}}}$.
4. Calculate: $t_a = \frac{x_a - MI}{\frac{\sigma}{\sqrt{n}}} + \lambda$.
5. Calculate: Power = $1 - T'_{df,\lambda}(t_a)$, where $T'_{df,\lambda}(x)$ is the area under a noncentral- t curve with degrees of freedom df and noncentrality parameter λ to the left of x .

Procedure Options

This section describes the options that are specific to this procedure. These are located on the Design tab. For more information about the options of other tabs, go to the Procedure Window chapter.

Design Tab

The Design tab contains most of the parameters and options that you will be concerned with.

Solve For

Solve For

This option specifies the parameter to be calculated from the values of the other parameters. Under most conditions, you would select either *Power* or *Sample Size*.

Select *Sample Size* when you want to determine the sample size needed to achieve a given power and alpha error level.

Select *Power* when you want to calculate the power of an experiment that has already been run.

Test

Alternative Hypothesis

This option specifies the alternative hypothesis. This implicitly specifies the direction of the hypothesis test. The null hypothesis is always $H_0 : \text{Mean0} = \text{Mean1}$.

Note that the alternative hypothesis enters into power calculations by specifying the rejection region of the hypothesis test. Its accuracy is critical.

Possible selections are:

- **Ha: Mean0 \neq Mean1**

This is the most common selection. It yields the *two-tailed t-test*. Use this option when you are testing whether the means are different but you do not want to specify beforehand which mean is larger. Many scientific journals require two-tailed tests.

- **Ha: Mean0 < Mean1**

This option yields a *one-tailed t-test*. Use it when you are only interested in the case in which Mean1 is greater than Mean0.

- **Ha: Mean0 > Mean1**

This options yields a *one-tailed t-test*. Use it when you are only interested in the case in which Mean1 is less than Mean0.

Nonparametric Adjustment

This option makes appropriate sample size adjustments for the Wilcoxon test. Results by Al-Sunduqchi and Guenther (1990) indicate that power calculations for the Wilcoxon test may be made using the standard *t-test* formulations with a simple adjustment to the sample size. The size of the adjustment depends upon the actual distribution of the data. They give sample size adjustment factors for four distributions. These are 1 for the uniform distribution, $2/3$ for the double exponential distribution, $9 / \pi^2$ for the logistic distribution, and $\pi / 3$ for the normal distribution.

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The options are as follows:

- **Ignore**
Do not make a Wilcoxon adjustment. This indicates that you want to analyze a t -test, not the Wilcoxon test.
- **Uniform**
Make the Wilcoxon sample size adjustment assuming the uniform distribution. Since the factor is one, this option performs the same as Ignore. It is included for completeness.
- **Double Exponential**
Make the Wilcoxon sample size adjustment assuming that the data actually follow the double exponential distribution.
- **Logistic**
Make the Wilcoxon sample size adjustment assuming that the data actually follow the logistic distribution.
- **Normal**
Make the Wilcoxon sample size adjustment assuming that the data actually follow the normal distribution.

Population Size

This is the number of subjects in the population. Usually, you assume that samples are drawn from a very large (infinite) population. Occasionally, however, situations arise in which the population of interest is of limited size. In these cases, appropriate adjustments must be made.

When a finite population size is specified, the standard deviation is reduced according to the formula:

$$\sigma_1^2 = \left(1 - \frac{n}{N}\right)\sigma^2$$

where n is the sample size, N is the population size, σ is the original standard deviation, and σ_1 is the new standard deviation.

The quantity n/N is often called the sampling fraction. The quantity $\left(1 - \frac{n}{N}\right)$ is called the *finite population correction factor*.

Power and Alpha

Power

This option specifies one or more values for power. Power is the probability of rejecting a false null hypothesis, and is equal to one minus Beta. Beta is the probability of a type-II error, which occurs when a false null hypothesis is not rejected.

Values must be between zero and one. Historically, the value of 0.80 (Beta = 0.20) was used for power. Now, 0.90 (Beta = 0.10) is also commonly used.

A single value may be entered here or a range of values such as *0.8 to 0.95 by 0.05* may be entered.

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Alpha

This option specifies one or more values for the probability of a type-I error. A type-I error occurs when a true null hypothesis is rejected.

Values must be between zero and one. Historically, the value of 0.05 has been used for alpha. This means that about one test in twenty will falsely reject the null hypothesis. You should pick a value for alpha that represents the risk of a type-I error you are willing to take in your experimental situation.

You may enter a range of values such as *0.01 0.05 0.10* or *0.01 to 0.10 by 0.01*.

Sample Size

N (Sample Size)

This option specifies one or more values of the sample size, the number of individuals in the study. This value must be an integer greater than one. Note that you may enter a list of values using the syntax *50,100,150,200,250* or *50 to 250 by 50*.

Effect Size – Means

Mean0 (Null or Baseline)

This option specifies one or more values of the mean corresponding to the null hypothesis. If you are analyzing a paired *t*-test, this value should be zero.

Only the difference between Mean0 and Mean1 is used in the calculations.

Means1 (Alternative)

This option specifies one or more values of the mean corresponding to the alternative hypothesis. If you are analyzing a paired *t*-test, this value represents the mean difference that you are interested in.

Only the difference between Mean0 and Mean1 is used in the calculations.

Effect Size – Standard Deviation

Standard Deviation

This option specifies one or more values of the standard deviation. This must be a positive value. Be sure to use the standard deviation of *X* and not the standard deviation of the mean (the standard error).

When this value is not known, you must supply an estimate of it. *PASS* includes a special module for estimating the standard deviation. This module may be loaded by pressing the *SD* button. Refer to the Standard Deviation Estimator chapter for further details.

Known Standard Deviation

This option specifies whether the standard deviation (σ) is known or unknown. In almost all experimental situations, the standard deviation is not known. However, great calculation efficiencies are obtained if the standard deviation is assumed to be known.

When this box is checked, the program performs its calculations assuming that the standard deviation is known. This results in the use of the normal distribution in all probability calculations. Calculations using this option will be much faster than for the unknown standard deviation case. The results for either case will be close when the sample size is over 30.

When this box is not checked, the program assumes that the standard deviation is not known and will be estimated from the data when the *t*-test is run. This results in probability calculations using the noncentral-*t* distribution. This distribution requires a lot more calculations than does the normal distribution.

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The calculation speed comes into play whenever the Find option is set to something besides *Beta*. In these cases, the program uses a special searching algorithm which requires numerous iterations. You will note a real difference in calculation speed depending on whether this option is checked.

A reasonable strategy would be to leave this option checked while you are experimenting with the parameters and then turn it off when you are ready for your final results.

Example 1 – Power after a Study

This example will cover the situation in which you are calculating the power of a *t*-test on data that have already been collected and analyzed. For example, you might be playing the role of a reviewer, looking at the power of *t*-test from a study you are reviewing. In this case, you would not vary the means, standard deviation, or sample size since they are given by the experiment. Instead, you investigate the power of the significance tests. You might look at the impact of different alpha values on the power.

Suppose an experiment involving 100 individuals yields the following summary statistics:

Hypothesized mean (M0)	100.0
Sample mean (M1)	110.0
Sample standard deviation	40.0
Sample size	100

Given the above data, analyze the power of a *t*-test which tests the hypothesis that the population mean is 100 versus the alternative hypothesis that the population mean is 110. Consider the power at significance levels 0.01, 0.05, 0.10 and sample sizes 20 to 120 by 20.

Note that we have set *M1* equal to the sample mean. In this case, we are studying the power of the *t*-test for a mean difference the size of that found in the experimental data.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 1** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Power
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Ignore
Population Size	Infinite
Alpha	0.01 0.05 0.10
N (Sample Size)	20 to 120 by 20
Mean0 (Null or Baseline)	100
Mean1 (Alternative)	110
S (Standard Deviation)	40
Known Standard Deviation	Not checked

Tests for One Mean

Annotated Output

Click the Calculate button to perform the calculations and generate the following output.

Numeric Results

Numeric Results for One-Sample T-Test

Null Hypothesis: Mean0 = Mean1 Alternative Hypothesis: Mean0 ≠ Mean1
Unknown standard deviation.

Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.06051	20	0.01000	0.93949	100.0	110.0	40.0	0.250
0.14435	40	0.01000	0.85565	100.0	110.0	40.0	0.250
0.24401	60	0.01000	0.75599	100.0	110.0	40.0	0.250
0.34953	80	0.01000	0.65047	100.0	110.0	40.0	0.250
0.45316	100	0.01000	0.54684	100.0	110.0	40.0	0.250
0.54958	120	0.01000	0.45042	100.0	110.0	40.0	0.250
0.18590	20	0.05000	0.81410	100.0	110.0	40.0	0.250

(report continues)

Report Definitions

Power is the probability of rejecting a false null hypothesis. It should be close to one.
N is the size of the sample drawn from the population. To conserve resources, it should be small.
Alpha is the probability of rejecting a true null hypothesis. It should be small.
Beta is the probability of accepting a false null hypothesis. It should be small.
Mean0 is the value of the population mean under the null hypothesis. It is arbitrary.
Mean1 is the value of the population mean under the alternative hypothesis. It is relative to Mean0.
Sigma is the standard deviation of the population. It measures the variability in the population.
Effect Size, |Mean0-Mean1|/Sigma, is the relative magnitude of the effect under the alternative.

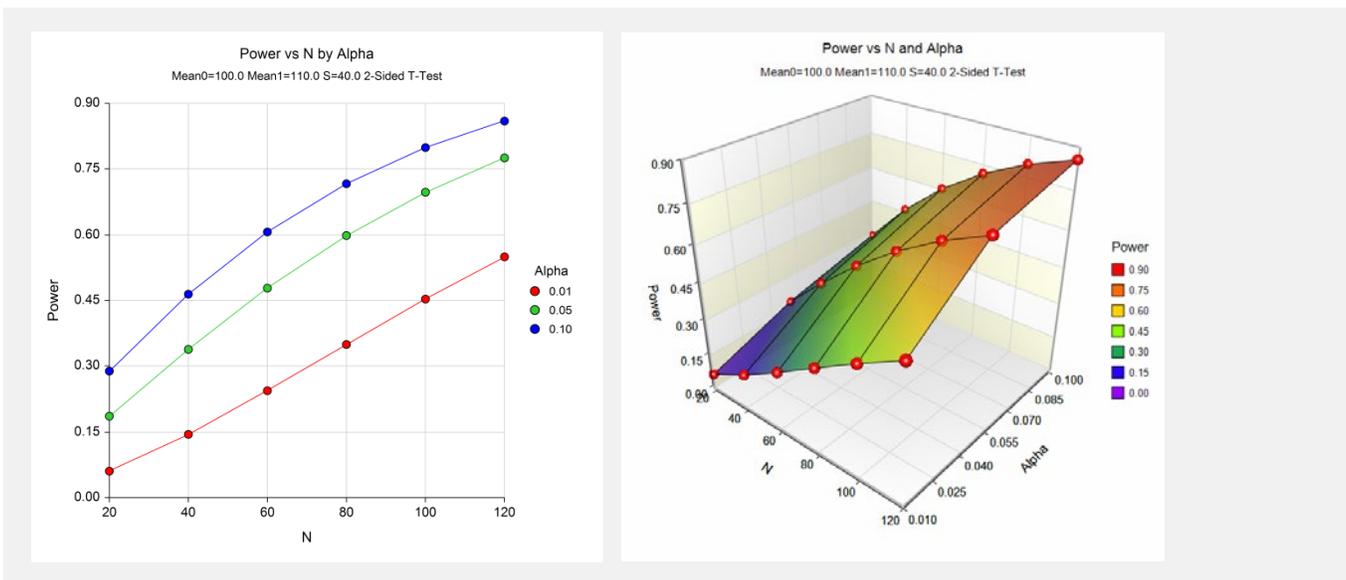
Summary Statements

A sample size of 20 achieves 6% power to detect a difference of -10.0 between the null hypothesis mean of 100.0 and the alternative hypothesis mean of 110.0 with an estimated standard deviation of 40.0 and with a significance level (alpha) of 0.01000 using a two-sided one-sample t-test.

This report shows the values of each of the parameters, one scenario per row. The values of power and beta were calculated from the other parameters.

The definitions of each column are given in the Report Definitions section.

Plots Section



These plots show the relationship between sample size and power for various values of alpha.

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Example 2 – Finding the Sample Size

This example will consider the situation in which you are planning a study that will use the one-sample t -test and want to determine an appropriate sample size. This example is more subjective than the first because you now have to obtain estimates of all the parameters. In the first example, these estimates were provided by the data.

In studying deaths from SIDS (Sudden Infant Death Syndrome), one hypothesis put forward is that infants dying of SIDS weigh less than normal at birth. Suppose the average birth weight of infants is 3300 grams with a standard deviation of 663 grams. Use an alpha of 0.05 and power of both 0.80 and 0.90. How large a sample of SIDS infants will be needed to detect a drop in average weight of 25%? Of 10%? Of 5%? Note that applying these percentages to the average weight of 3300 yields 2475, 2970, and 3135.

Although a one-sided hypothesis is being considered, sample size estimates will assume a two-sided alternative to keep the research design in line with other studies.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 2** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Sample Size
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Ignore
Population Size	Infinite
Power	0.80 0.90
Alpha	0.05
Mean0 (Null or Baseline)	3300
Mean1 (Alternative)	2475 2970 3135
S (Standard Deviation)	663
Known Standard Deviation	Not checked

Output

Click the Calculate button to perform the calculations and generate the following output.

Numeric Results

Numeric Results for One-Sample T-Test

Null Hypothesis: Mean0 = Mean1 Alternative Hypothesis: Mean0 ≠ Mean1
Unknown standard deviation.

Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.85339	8	0.05000	0.14661	3300.0	2475.0	663.0	1.244
0.90307	9	0.05000	0.09693	3300.0	2475.0	663.0	1.244
0.80426	34	0.05000	0.19574	3300.0	2970.0	663.0	0.498
0.90409	45	0.05000	0.09591	3300.0	2970.0	663.0	0.498
0.80105	129	0.05000	0.19895	3300.0	3135.0	663.0	0.249
0.90070	172	0.05000	0.09930	3300.0	3135.0	663.0	0.249

This report shows the values of each of the parameters, one scenario per row. Since there were three values of Mean1 and two values of beta, there are a total of six rows in the report.

Tests for One Mean

We were solving for the sample size, N . Notice that the increase in sample size seems to be most directly related to the difference between the two means. The difference in beta values does not seem to be as influential, especially at the smaller sample sizes.

Note that even though we set the beta values at 0.1 and 0.2, these are not the beta values that were achieved. This happens because N can only take on integer values. The program selects the first value of N that gives at least the values of alpha and beta that were desired.

Example 3 – Finding the Minimum Detectable Difference

This example will consider the situation in which you want to determine how small of a difference between the two means can be detected by the t -test with specified values of the other parameters.

Continuing with the previous example, suppose about 50 SIDS deaths occur in a particular area per year. Using 50 as the sample size, 0.05 as alpha, and 0.20 as beta, how large of a difference between the means is detectable?

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 3** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Mean1 (Search<Mean0)
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Ignore
Population Size	Infinite
Power	0.80
Alpha	0.05
N (Sample Size)	50
Mean0 (Null or Baseline)	3300
S (Standard Deviation)	663
Known Standard Deviation	Not checked

Output

Click the Calculate button to perform the calculations and generate the following output.

Numeric Results

Numeric Results for One-Sample T-Test							
Null Hypothesis: Mean0 = Mean1				Alternative Hypothesis: Mean0 ≠ Mean1			
Unknown standard deviation.							
Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.80000	50	0.05000	0.20000	3300.0	3032.0	663.0	0.404

With a sample of 50, a difference of $3300 - 3032 = 268$ would be detectable. This difference represents about an 8% decrease in weight.

Example 4 – Paired T-Test

Usually, a researcher designs a study to compare two or more groups of subjects, so the one sample case described in this chapter occurs infrequently. However, there is a popular research design that does lead to the single mean test: *paired observations*.

For example, suppose researchers want to study the impact of an exercise program on the individual's weight. To do so they randomly select N individuals, weigh them, put them through the exercise program, and weigh them again. The variable of interest is not their actual weight, but how much their weight changed.

In this design, the data are analyzed using a one-sample t -test on the differences between the paired observations. The null hypothesis is that the average difference is zero. The alternative hypothesis is that the average difference is some nonzero value.

To study the impact of an exercise program on weight loss, the researchers decide to conduct a study that will be analyzed using the paired t -test. A sample of individuals will be weighed before and after a specified exercise program that will last three months. The difference in their weights will be analyzed.

Past experiments of this type have had standard deviations in the range of 10 to 15 pounds. The researcher wants to detect a difference of 5 pounds or more. Alpha values of 0.01 and 0.05 will be tried. Beta is set to 0.20 so that the power is 80%. How large of a sample must the researchers take?

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 4** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Sample Size
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Ignore
Population Size	Infinite
Power	0.80
Alpha	0.01 0.05
Mean0 (Null or Baseline)	0
Mean1 (Alternative)	-5
S (Standard Deviation)	10 12.5 15
Known Standard Deviation	Not checked
Plots Tab	
X-Y-Z Plots Live Edit/Rotate	Checked

Tests for One Mean

Output

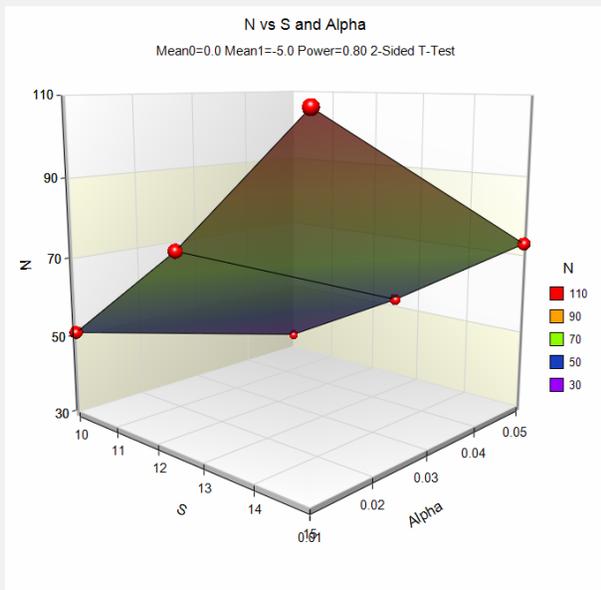
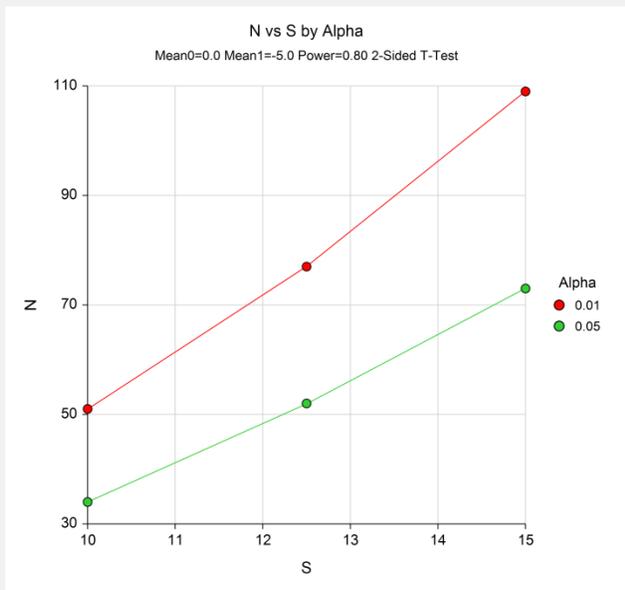
Click the Calculate button to perform the calculations and generate the following output.

Numeric Results and Plots

Numeric Results for One-Sample T-Test

Null Hypothesis: Mean0 = Mean1 Alternative Hypothesis: Mean0 ≠ Mean1
 Unknown standard deviation.

Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.80939	51	0.01000	0.19061	0.0	-5.0	10.0	0.500
0.80778	34	0.05000	0.19222	0.0	-5.0	10.0	0.500
0.80434	77	0.01000	0.19566	0.0	-5.0	12.5	0.400
0.80779	52	0.05000	0.19221	0.0	-5.0	12.5	0.400
0.80252	109	0.01000	0.19748	0.0	-5.0	15.0	0.333
0.80230	73	0.05000	0.19770	0.0	-5.0	15.0	0.333



The report shows the values of each of the parameters, one scenario per row. We were solving for the sample size, *N*.

Note that depending on our choice of assumptions, the sample size ranges from 34 to 109. Hence, the researchers have to make a careful determination of which standard deviation and significance level should be used.

Example 5 – Wilcoxon Test

The Wilcoxon test, a nonparametric analog of the paired comparison t -test, is recommended when the distribution of the data is symmetrical, but not normal. A study by Al-Sunduqchi (1990) showed that sample size and power calculations for the Wilcoxon test can be made using the standard t -test results with a simple adjustment to the sample size.

Suppose the researchers in Example 4 want to compare sample size requirements of the t -test with those of the Wilcoxon test. They would use the same values, only this time the Nonparametric Adjustment would be set to *double exponential*. The double exponential was selected because it requires the largest adjustment of the distributions available in *PASS* and they wanted to know what the largest adjustment was.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 5** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Sample Size
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Double Exponential
Population Size.....	Infinite
Power.....	0.80
Alpha.....	0.01 0.05
Mean0 (Null or Baseline)	0
Mean1 (Alternative)	-5
S (Standard Deviation)	10 12.5 15
Known Standard Deviation	Not checked
Plots Tab	
X-Y-Z Plots Live Edit/Rotate	Checked

Tests for One Mean

Output

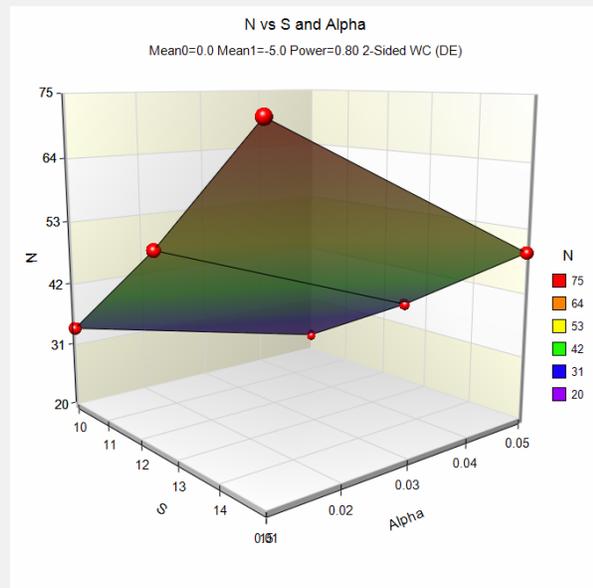
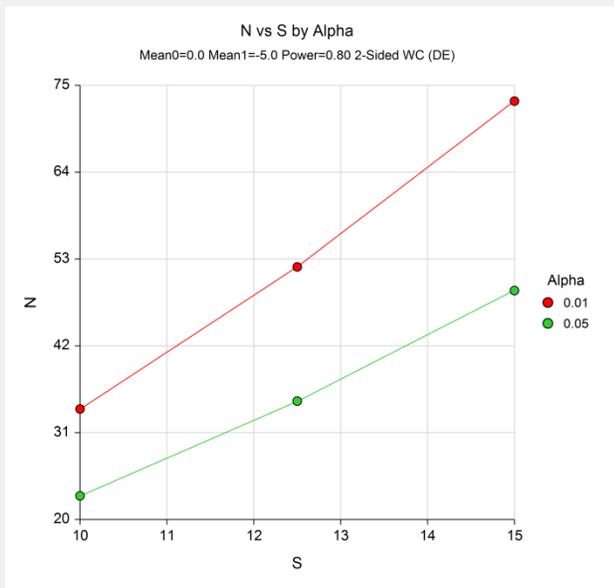
Click the Calculate button to perform the calculations and generate the following output.

Numeric Results and Plots

Numeric Results for Wilcoxon Test (Double Exponential Distribution)

Null Hypothesis: Mean0 = Mean1 Alternative Hypothesis: Mean0 ≠ Mean1
 Unknown standard deviation.

Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.80939	34	0.01000	0.19061	0.0	-5.0	10.0	0.500
0.80778	23	0.05000	0.19222	0.0	-5.0	10.0	0.500
0.81069	52	0.01000	0.18931	0.0	-5.0	12.5	0.400
0.80779	35	0.05000	0.19221	0.0	-5.0	12.5	0.400
0.80252	73	0.01000	0.19748	0.0	-5.0	15.0	0.333
0.80230	49	0.05000	0.19770	0.0	-5.0	15.0	0.333



If you compare these sample size values with those of Example 4, you will find that these are about two-thirds of those required for the *t*-test. This is the value of the adjustment factor for the Wilcoxon test when the underlying distribution is the double exponential.

Tests for One Mean

Example 6 – Validation using Zar

Zar (1984) pages 111-112 presents an example in which $\text{Mean}_0 = 0.0$, $\text{Mean}_1 = 1.0$, $S = 1.25$, $\alpha = 0.05$, and $N = 12$. Zar obtains an approximate power of 0.72.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 6** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Power
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Ignore
Population Size	Infinite
Alpha	0.05
N (Sample Size)	12
Mean0 (Null or Baseline)	0
Mean1 (Alternative)	1
S (Standard Deviation)	1.25
Known Standard Deviation	Not checked

Output

Click the Calculate button to perform the calculations and generate the following output.

Numeric Results

Numeric Results for One-Sample T-Test

Null Hypothesis: $\text{Mean}_0 = \text{Mean}_1$ Alternative Hypothesis: $\text{Mean}_0 \neq \text{Mean}_1$
Unknown standard deviation.

Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.71366	12	0.05000	0.28634	0.0	1.0	1.3	0.800

The difference between the power computed by PASS of 0.71366 and the 0.72 computed by Zar is mostly due to Zar's use of an approximation to the noncentral t distribution.

Tests for One Mean

Example 7 – Validation using Machin

Machin, Campbell, Fayers, and Pinol (1997) page 37 presents an example in which $\text{Mean}_0 = 0.0$, $\text{Mean}_1 = 0.2$, $S = 1.0$, $\alpha = 0.05$, and $\beta = 0.20$. They obtain a sample size of 199.

Setup

This section presents the values of each of the parameters needed to run this example. First, from the PASS Home window, load the **Tests for One Mean** procedure window by expanding **Means**, then **One Mean**, then clicking on **Test (Inequality)**, and then clicking on **Tests for One Mean**. You may then make the appropriate entries as listed below, or open **Example 7** by going to the **File** menu and choosing **Open Example Template**.

<u>Option</u>	<u>Value</u>
Design Tab	
Solve For	Sample Size
Alternative Hypothesis	Ha: Mean0 ≠ Mean1
Nonparametric Adjustment	Ignore
Population Size	Infinite
Power	0.80
Alpha	0.05
Mean0 (Null or Baseline)	0
Mean1 (Alternative)	0.2
S (Standard Deviation)	1.0
Known Standard Deviation	Not checked

Output

Click the Calculate button to perform the calculations and generate the following output.

Numeric Results**Numeric Results for One-Sample T-Test**

Null Hypothesis: $\text{Mean}_0 = \text{Mean}_1$ Alternative Hypothesis: $\text{Mean}_0 \neq \text{Mean}_1$
Unknown standard deviation.

Power	N	Alpha	Beta	Mean0	Mean1	S	Effect Size
0.80169	199	0.05000	0.19831	0.0	0.2	1.0	0.200

The sample size of 199 matches Machin's result.