

# How do we conduct a power analysis for a two-group independent sample t-test using Stata?

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Power analysis is a statistical tool used to determine the minimum sample size required to detect a significant difference between two groups in a study. In order to conduct a power analysis for a two-group independent sample t-test using Stata, several steps need to be followed.

First, the researcher needs to specify the desired level of significance ( $\alpha$ ) and the desired power level (typically 0.80 or 0.90). Then, the researcher needs to input the expected effect size, which is the estimated difference between the two groups, and the standard deviation of the outcome variable.

Next, Stata will generate the sample size needed to achieve the desired power level. It will also calculate the critical t-value and the corresponding p-value for the specified sample size. These values can be used to determine the minimum detectable effect size for the given sample size.

Once the sample size is determined, the researcher can use Stata to generate a power curve, which displays the relationship between sample size, effect size, and power. This can help the researcher visualize the trade-off between increasing sample size and increasing power.

In summary, conducting a power analysis for a two-group independent sample t-test using Stata involves specifying the desired significance and power levels, inputting the effect size and standard deviation, and interpreting the results to determine the necessary sample size and minimum detectable effect size. This analysis is important in ensuring that a study has adequate statistical power to detect meaningful differences between groups.

## Power Analysis for Two-group Independent sample t-test | Stata Data Analysis Examples

### Examples

**Example 1. A clinical dietician wants to compare two different diets, A and B, for diabetic patients. She hypothesizes that diet A (Group 1) will be better than diet B (Group 2), in terms of lower blood glucose. She plans to get a random sample of**

diabetic patients and randomly assign them to one of the two diets. At the end of the experiment, which lasts 6 weeks, a fasting blood glucose test will be conducted on each patient. She also expects that the average difference in blood glucose measure between the two group will be about 10 mg/dl. Furthermore, she also assumes the standard deviation of blood glucose distribution for diet A to be 15 and the standard deviation for diet B to be 17. The dietician wants to know the number of subjects needed in each group assuming equal sized groups.

Example 2. An audiologist wanted to study the effect of gender on the response time to a certain sound frequency. He suspected that men were better at detecting this type of sound than were women. He took a random sample of 20 male and 20 female subjects for this experiment. Each subject was be given a button to press

when he/she heard the sound. The audiologist then measured the response time - the time between the sound was emitted and the time the button was pressed.

Now, he

wants to know what the statistical power is based on his total of 40 subjects to detect the gender difference.

### Prelude to The Power Analysis

There are two different aspects of power analysis. One is to calculate the necessary sample size for a specified power as in Example 1. The other aspect is to calculate the power when given a specific sample size as in Example 2. Technically, power is the probability of rejecting the null hypothesis when the specific alternative hypothesis is true.

For the power analyses below, we are going to focus on Example 1, calculating the sample size for a given statistical power of testing the difference in the effect of diet A and diet B. Notice the assumptions that

the dietician has made in order to perform the power analysis. Here is the information we have to know or have to assume in order to perform the power analysis:

Notice that in the first example, the dietician didn't specify the mean for each group, instead she only specified the difference of the two means. This is because that she is only interested in the difference, and it does not matter what the means are as long as the difference is the same.

### Power Analysis

In Stata, it is fairly straightforward to perform power analysis for comparing means. For example, we can use Stata's power command for our calculation as shown below. We first specify that we have two means. Next, we specify the two means, the mean for Group 1 (diet A) and the mean for Group 2 (diet B). Since what really matters is the

difference, instead of means for each group, we can enter a mean of zero for Group 1 and 10 for the mean of Group 2, so that the difference in means will be 10. Next, we specify the standard deviation for the first population and standard deviation for the second population. The default significance level (alpha level) is .05.

For this example we will set the power to be at .8, which is the default value.

```
power twomeans 0 10, sd1(15) sd2(17)
```

Performing iteration ...

Estimated sample sizes for a two-sample means test  
Satterthwaite's t test assuming unequal variances  
H0:  $m_2 = m_1$  versus Ha:  $m_2 \neq m_1$

Study parameters:

alpha = 0.0500

power = 0.8000

delta = 10.0000

m1 = 0.0000

**$m_2 = 10.0000$**

**$sd_1 = 15.0000$**

**$sd_2 = 17.0000$**

**Estimated sample sizes:**

**$N = 84$**

**$N$  per group = 42**

The calculation results indicate that we need 42 subjects for diet A and another 42 subject for diet B in our sample in order the effect. Now, let's use another pair of means with the same difference. As we have discussed earlier, the results should be the same, and they are.

**power twomeans 5 15, sd1(15) sd2(17)**

**Performing iteration ...**

**Estimated sample sizes for a two-sample means test  
Satterthwaite's t test assuming unequal variances**

**$H_0: m_2 = m_1$  versus  $H_a: m_2 \neq m_1$**

**Study parameters:**

**alpha = 0.0500**

**power = 0.8000**

**delta = 10.0000**

**m1 = 5.0000**

**m2 = 15.0000**

**sd1 = 15.0000**

**sd2 = 17.0000**

**Estimated sample sizes:**

**N = 84**

**N per group = 42**

Now the dietician may feel that a total sample size of 84 subjects is beyond her budget. One way of reducing the sample size is to increase the Type I error rate, or the alpha level. Let's say instead of using alpha level of .05 we will use .07. Then our sample size will reduce by 4 for each group as shown below.

**power twomeans 5 15, sd1(15) sd2(17) alpha(.07)**

**Performing iteration ...**

## Estimated sample sizes for a two-sample means test Satterthwaite's t test assuming unequal variances

$H_0: \mu_2 = \mu_1$  versus  $H_a: \mu_2 \neq \mu_1$

Study parameters:

$\alpha = 0.0700$

power = 0.8000

delta = 10.0000

$\mu_1 = 5.0000$

$\mu_2 = 15.0000$

sd1 = 15.0000

sd2 = 17.0000

Estimated sample sizes:

$N = 76$

$N$  per group = 38

Now suppose the dietician can only collect data on 60 subjects with 30 in each group. What will the statistical power for her t-test be with respect to alpha level of .05?

**power twomeans 0 10, sd1(15) sd2(17) n(60)**

**Estimated power for a two-sample means test**

**Satterthwaite's t test assuming unequal variances**

**H0:  $m_2 = m_1$  versus Ha:  $m_2 \neq m_1$**

**Study parameters:**

**alpha = 0.0500**

**N = 60**

**N per group = 30**

**delta = 10.0000**

**m1 = 0.0000**

**m2 = 10.0000**

**sd1 = 15.0000**

**sd2 = 17.0000**

**Estimated power:**

**power = 0.6610**

**What if she actually collected her data on 60 subjects but with 40 on diet A and 20 on diet B instead of equal sample sizes in the groups?**

**power twomeans 0 10, sd1(15) sd2(17) n(60) nratio(2)**

**Estimated power for a two-sample means test**

**Satterthwaite's t test assuming unequal variances**

**H0:  $m_2 = m_1$  versus Ha:  $m_2 \neq m_1$**

**Study parameters:**

**alpha = 0.0500**

**N = 60**

**N1 = 20**

**N2 = 40**

**N2/N1 = 2.0000**

**delta = 10.0000**

**m1 = 0.0000**

**m2 = 10.0000**

**sd1 = 15.0000**

**sd2 = 17.0000**

**Estimated power:**

**power = 0.6232**

**As you can see the power goes down from .66 to .62 even though the total number of subjects**

is the same. This is why we always say that a balanced design is more efficient.

## Discussion

An important technical assumption is the normality assumption. If the distribution is skewed, then a small sample size may not have the power shown in the results, because the value in the results is calculated using the method based on the normality assumption. We have seen that in order to compute the power or the sample size, we have to make a number of assumptions. These assumptions are used not only for the purpose of calculation, but are also used in the actual t-test itself. So one important side benefit of performing power analysis is to help us to better understand our designs and our hypotheses.

We have seen in the power calculation process that what matters in the two-independent sample t-test is the difference in the

means and the standard deviations for the two groups. This leads to the concept of effect size. In this case, the effect size will be the difference in means over the pooled standard deviation. The larger the effect size, the larger the power for a given sample size. Or, the larger the effect size, the smaller sample size needed to achieve the same power. So, a good estimate of effect size is the key to a good power analysis. But it is not always an easy task to determine the effect size. Good estimates of effect size come from the existing literature or from pilot studies. One may also want to consider using the minimum effect size of interest.

**See Also**