What is the appropriate power analysis for an independent sample t-test?

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Power analysis is a statistical method used to determine the appropriate sample size for a study based on the expected effect size, alpha level, and desired power. In the context of an independent sample t-test, power analysis is used to calculate the minimum sample size needed to detect a significant difference between two independent groups with a certain level of power and significance. This ensures that the study has enough statistical power to accurately detect a true effect, while minimizing the risk of Type I and Type II errors. By conducting an appropriate power analysis, researchers can ensure the validity and reliability of their results, and make informed decisions about the sample size needed for their study.

Power Analysis for Independent Sample t-test

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 then 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 SPSS, it is fairly straightforward to perform power analysis for comparing means. For example, we can use SPSS's power means independent command for our calculation as shown below. For this example we will set the power to be at .8.

power means independent /parameters test=nondirectional significance=0.05 power=.8 nratio=1 mean=0 10 sd=15 17.

Power Analysis - Independent Sample Means

Power Analysis Table

	N1	N2	Actual Power[b]	Test Assumptions				
				Power	Std. Dev1	Std. Dev2	Mean Difference	Sig.
Test for Mean Difference[a]	42	42	.806	.8	15	17	10.000	.05

a. Two-sided test.

b. Based on noncentral t-distribution.

The calculation results indicate that we need 42 subjects for diet A and

another 42 subjects for diet B in our sample in order to see 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 means independent
/parameters test=nondirectional significance=0.05 power=.8 nratio=1 mean=5 15 sd=15 17.

Power Analysis - Independent Sample Means

Power Analysis Table

	N1	N2	Actual Power[b]	Test Assumptions				
				Power	Std. Dev1	Std. Dev2	Mean Difference	Sig.
Test for Mean Difference[a]	42	42	.806	.8	15	17	10.000	.05

a. Two-sided test.

b. Based on noncentral t-distribution.

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 means independent
/parameters test=nondirectional significance=0.07

power=.8 nratio=1 mean=0 10 sd=15 17.

Power Analysis - Independent Sample Means

Power Analysis Table

	N1	N2	Actual Power[b]	Test Assumptions				
				Power	Std. Dev1	Std. Dev2	Mean Difference	Sig.
Test for Mean Difference[a]	38	38	.810	.8	15	17	10.000	.07

a. Two-sided test.

b. Based on noncentral t-distribution.

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 means independent /parameters test=nondirectional significance=0.05 n=30 30 mean=0 10 sd=15 17.

Power Analysis - Independent Sample Means

Power Analysis Table

	Power[b]	Test Assumptions					
		N1	Std. Dev1	N2	Std. Dev2	Mean Difference	Sig.
Test for Mean Difference[a]	.661	30	15	30	17	10.000	.05

a. Two-sided test.

b. Based on noncentral t-distribution.

**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 means independent
/parameters test=nondirectional significance=0.05 n=40 20 mean=0 10 sd=15 17.**

Power Analysis - Independent Sample Means

Power Analysis Table

	Power[b]	Test Assumptions					
		N1	Std. Dev1	N2	Std. Dev2	Mean Difference	Sig.
Test for Mean Difference[a]	.583	40	15	20	17	10.000	.05

a. Two-sided test.

b. Based on noncentral t-distribution.

**As you can see the power goes down from .661 to .583 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.

See Also