

How Effect Size Impacts Sample Size

Note and Disclaimer:

- (1) This PDF is part of YouTube tutorials (<https://youtu.be/OxKYF93gMMw>). This PDF is for individual, personal usage only.
- (2) The author accepts no responsibility for the topicality, correctness, completeness or quality of the information provided.

The following effect size numbers are based on Jacob Cohen's *Statistical Power Analysis for the Behavioral Sciences* (Second Edition, p. 82)

Effect Size	d	r
Small	0.2	0.1
Medium	0.5	0.3
Large	0.8	0.5

Cohen's d

Cohen d is used to quantify the size of the difference between two groups, taking into account the variability within each group.

That is, x is categorical variable, whereas y is numerical variable (i.e., Y is on a continuous scale).

$$d = \frac{m_2 - m_1}{s_{pooled}} = \frac{m_2 - m_1}{\sqrt{\frac{s_1^2 + s_2^2}{2}}}$$

Pearson r

When both x and y are numerical, we need to use pearson correlation coefficient to measure effect size r .

$$r_{xy} = \frac{cov(x, y)}{s_x s_y} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2} \sqrt{\sum_{i=1}^n (y_i - \bar{y})^2}}$$

Convert r to d

$$d = \frac{2r}{\sqrt{1 - r^2}}$$

Convert d to r

$$r = \frac{d}{\sqrt{4 + d^2}}$$

Effect Size and Sample Size

In general, as the effect size increases, the required sample size decreases, assuming that statistical power ($1 - \beta$) and the alpha level (α) are held constant, respectively.

R Code Example 1: t-test

To calculate the needed sample size for a two-sample t-test with a specified power of 0.8, a significance level of 0.05, and an effect size of 0.5, you can use the `pwr.t.test` function in R.

effect size = 0.50

```
# A simple way of writing the R code
library(pwr)
pwr.t.test(n=NULL,
           d = 0.5,
           sig.level = 0.05,
           power = 0.80,
           type = "two.sample",
           alternative="two.sided")

##
##      Two-sample t test power calculation
##
##              n = 63.76561
##              d = 0.5
##      sig.level = 0.05
##              power = 0.8
##      alternative = two.sided
##
## NOTE: n is number in *each* group
```

Increasing the effect size from 0.5 to 0.8:

effect size = 0.80

```
# A simple way of writing the R code
pwr.t.test(n=NULL,
           d = 0.8,
           sig.level = 0.05,
           power = 0.80,
           type = "two.sample",
           alternative="two.sided")

##
##      Two-sample t test power calculation
##
##              n = 25.52458
##              d = 0.8
##      sig.level = 0.05
##              power = 0.8
```

```
##      alternative = two.sided
##
## NOTE: n is number in *each* group
```

R Code Example 2: Correlation

effect size = 0.30

A simple way of writing the R code

```
pwr.r.test(n = NULL,  
           r = 0.3,  
           sig.level = 0.05,  
           power = 0.80,  
           alternative = "two.sided")
```

```
##  
##      approximate correlation power calculation (arctangh transformation)  
##  
##              n = 84.07364  
##              r = 0.3  
##      sig.level = 0.05  
##      power = 0.8  
##      alternative = two.sided
```

effect size = 0.50

A simple way of writing the R code

```
pwr.r.test(n = NULL,  
           r = 0.5,  
           sig.level = 0.05,  
           power = 0.80,  
           alternative = "two.sided")
```

```
##  
##      approximate correlation power calculation (arctangh transformation)  
##  
##              n = 28.24841  
##              r = 0.5  
##      sig.level = 0.05  
##      power = 0.8  
##      alternative = two.sided
```