

12.5: Effect size for ANOVA

Introduction

As noted in the [t-test chapter](#) and our discussion of [statistical power](#), an **effect size** is a measure of the strength of a phenomenon. An effect size calculated from data is a descriptive statistic that indicates how large (or small) the difference is between two or more samples. Effect size measures help to provide context between statistical significance, i.e., p-values. Among other uses, effect size measures play an important role in meta-analysis studies biological significance (i.e., importance of the measured difference).

Estimation of effect size

eta-squared (η^2)

$$\eta^2 = \frac{SS_B}{SS_T}$$

where SS_B and SS_T are from the one-way ANOVA and refer to the **sum of squared among (between) groups** and the **total sum of squares**, respectively. η^2 measures the proportion of the variation in the response variable that can be explained by membership in one of the groups.

For example, η^2 of 0.15 or 15% is interpreted to mean that just 15% of the variation in the response variable can be attributed to membership in the groups (i.e., whether a subject was in control group or treatment group, only 15% of the differences between individuals can be attributed to having received control).

Note:

η^2 is just the unadjusted coefficient of determination, R^2 .

omega-squared (ω^2)

A similar, but “less biased” effect size estimate is given by omega-squared (ω^2) (Okada 2013). (The bias comes in because sample estimates were used.) Interpretation of ω^2 is the same as η^2 : measures the proportion of variation explained by membership in the groups. ω^2 is given as

$$\omega^2 = \frac{SS_B - (k-1)MS_W}{SS_T + MS_W}$$

The bias for η^2 is more pronounced with small sample size, so omega-squared is preferred. ω^2 will always be less than or equal to η^2 (Okada 2013).

R code

If you have not already done so, please install the package `effectsize`.

We'll use the example one-way ANOVA problem from [Chapter 12.2](#). I've added the data as `example.ch12` and some R script to load the data; scroll to bottom of this page or [click on the link](#)).

Get η^2

First, get the ANOVA model. There are several ways to do this within R (and Rcmdr), the most general is to use the general linear model function, `lm()`,

```
#Get the model
AnovaModel.4 <- lm(Difference~Group, data=example.ch12)
#turn it into format that the next command needs
aov_fit <- anova(AnovaModel.4)
#get eta
effectsize(aov_fit)
```

R output:

```
Parameter | Eta2 (partial) | 9e+01% CI
```

```
-----  
Group | 0.95 | [0.88, 0.97]
```

η^2 is 0.95 for the Difference group.

Get ω^2

R code:

```
omega_squared(aov_fit, partial = FALSE, ci = 0.95)
```

R output:

```
Parameter | Omega2 | 1e+02% CI
```

```
-----  
Group | 0.93 | [0.82, 0.97]
```

This is a case of a large effect due to group membership. The differences between A, B, and C means account for 93% of the variation. Note that both η^2 and ω^2 are close; note also that η^2 is greater than ω^2 .

Questions

1. In [Chapter 7.4](#) we introduced the concept of number needed to treat, NNT. Discuss the concept of “important differences” between sample means of a control group and a treatment group to NNT.
2. For the “No difference” group, calculate η^2 and ω^2 . Use the box plots shown in Figure 12.2.1 together with effect size statistics to discuss the relationship between statistical significance (p-value) and important difference.

Data set

```
example.ch12 <- read.table(header=TRUE, sep=",", text="
Group, No.difference, Difference
A, 12.04822, 11.336161
A, 12.67584, 13.476142
A, 12.99568, 12.961210
A, 12.01745, 11.746712
A, 12.34854, 11.275492
B, 12.17643, 7.167262
B, 12.77201, 5.136788
B, 12.07137, 6.820242
B, 12.94258, 5.318743
B, 12.07670, 7.153992
C, 12.58212, 3.344218
C, 12.69263, 3.792337
C, 12.60226, 2.444438
C, 12.02534, 2.576014
C, 12.60420, 4.575672")
#check the dataframe
head(example.ch12)
```

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