

# Cohen w (es\_cohen\_w)

Author: P. Stikker

Website: <a href="https://peterStatistics.com">https://peterStatistics.com</a>

YouTube: <a href="https://www.youtube.com/stikpet">https://www.youtube.com/stikpet</a>

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### Introduction

The *es\_cohen\_w* function (and *es\_cohen\_w\_arr* in VBA) calculates the effect size Cohen w for a goodness-of-fit test.

This document contains the details on how to use the functions, and formulas used in them.

### 1 About the Function

### 1.1 Input parameters:

• chi2

the chi-square test statistic.

 n the sample size

- Optional parameters
  - out (default is "value") only applies to VBA es\_cohen\_w
     Choice what to show as result. Either:
    - "value": the effect size value
    - "qual": the qualification/classification of the value

### 1.2 Output:

Value

The Cohen's w value

Qualification

The qualification/classification of the effect size using a rule of thumb

• The array version in VBA (es\_cohen\_w\_arr) requires two rows and two columns.



### 1.3 Dependencies

#### Excel

None.

You can run the **es\_cohen\_w\_addHelp** macro so that the function will be available with some help in the 'User Defined' category in the functions overview.

### • Python

The following additional libraries will have to be installed/loaded:

o pandas

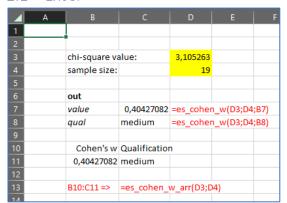
the data input needs to be a pandas data series, and the output is also a pandas dataframe.

#### R

No other libraries required.

# 2 Examples

### 2.1 Excel



### 2.2 Python

```
[2]: chi2 = 3.105263
n = 19
es_cohen_w(chi2, n)

[2]: Cohen's w Classification

0 0.404271 medium
```

### 2.3 R

## 3 Details of Calculations

### 3.1 The Effect Size

$$w = \sqrt{\frac{\chi_{GoF}^2}{n}}$$

Where:

 $\chi^2_{GOF}$  the Pearson chi-square goodness-of-fit value (see section **Error! Reference source not found.**)

 $\it n$  the sample size, i.e. the sum of all frequencies

Cramér's V can be determined from w using:

$$v = \frac{w}{\sqrt{k-1}}$$

### 3.2 Interpretation

Table 1

Rule of thumb for Cohen w interpretation

Cohen's w	Interpretation
0.00 < 0.10	Negligible
0.10 < 0.30	Small
0.30 < 0.50	Medium
0.50 or more	Large

Note. Adapted from Cohen (1988, pp. 224–225)

### 4 Sources

Cohen's w can be found in *Statistical power analysis for the behavioral sciences* (2nd ed) (Cohen, 1988), on page 216:

crepancy between these paired proportions over the cells in the following way:

$$\mathbf{w} = \sqrt{\sum_{i=1}^{m} \frac{(\mathbf{P}_{1i} - \mathbf{P}_{0i})^2}{\mathbf{P}_{0i}}},$$

Note: Cohen actually uses in the expression under the square root:

$$\sum_{i=1}^k \frac{(p_i - q_i)^2}{q_i}$$

Where:

- $p_i$  the proportion of the i-th category
- ullet q<sub>i</sub> the expected proportion of the i-th category
- *k* the number of categories
- *n* the sample size, i.e. the sum of all frequencies

A proof for this:

$$\sum_{i=1}^{k} \frac{(p_i - q_i)^2}{q_i} = \sum_{i=1}^{k} \frac{\left(\frac{F_i}{n} - \frac{E_i}{n}\right)^2}{\frac{E_i}{n}} = \sum_{i=1}^{k} \frac{\left(\frac{F_i - E_i}{n}\right)^2}{\frac{E_i}{n}} = \sum_{i=1}^{k} \frac{\frac{(F_i - E_i)^2}{n^2}}{\frac{E_i}{n}} = \sum_{i=1}^{k} \frac{n \times (F_i - E_i)^2}{n^2 \times E_i}$$

$$= \sum_{i=1}^{k} \frac{(F_i - E_i)^2}{n \times E_i} = \frac{1}{n} \times \sum_{i=1}^{k} \frac{(F_i - E_i)^2}{E_i} = \frac{1}{n} \times \chi_{GoF}^2 = \frac{\chi_{GoF}^2}{n}$$

Cohen's classification for his w:

small: **w** = .10, medium: **w** = .30, large: **w** = .50.

(Cohen, 1988, p. 227)

### References

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). L. Erlbaum

Associates.