

How to Perform a Chi Square Test by Hand

Why use it?

- Helps us find out if the experimental results are likely, or if the discrepancies too much to be random.
- Non-random results mean that some phenomena is causing the results.

Example: Do wood bugs prefer sand over gravel?

	observed	expected
sand	4	11
gravel	18	11
Total	22	22

We want to determine if there is a statistically significant difference between the observed data and what we would expect.

1. Outline the Null and Alternate Hypothesis

- Null Hypothesis: bugs choosing sand = bugs choosing gravel
- Tells us that there is no significant difference between observed and expected values
- Alternative Hypothesis: bugs choosing sand not equal to bugs choosing gravel
- Tells us that there is a significant difference between observed and expected values

2. Use the Formula

$$\chi^2 = \sum \frac{(o - e)^2}{e}$$

$$\chi^2 = \text{SAND} + \text{GRAVEL}$$

$$\chi^2 = \frac{(O - E)^2}{E} + \frac{(O - E)^2}{E}$$

$$\chi^2 = \frac{(4 - 11)^2}{11} + \frac{(18 - 11)^2}{11}$$

$$\chi^2 = \frac{(-7)^2}{11} + \frac{(7)^2}{11}$$

$$\chi^2 = 4.45 + 4.45$$

$$\chi^2 = 8.9$$

3. Select the Alpha Value

- Determines how picky we will be about the results.
- For this example, we will use 0.05.

<i>p</i> value	Degrees of Freedom							
	1	2	3	4	5	6	7	8
0.05	3.84	5.99	7.82	9.49	11.07	12.59	14.07	15.5
0.01	6.64	9.21	11.34	13.28	15.09	16.81	18.48	20.0

4. Determine the Degrees of Freedom

- In this example there are two groups: sand and gravel.
- The degrees of freedom is equal to the number of groups minus one.
- The degrees of freedom for this example is 1. (2 groups – 1 = 1)

5. Use the Chi Square Distribution Table to Determine the Critical Value

- With a *p* value of 0.05 and one degree of freedom, the critical value is 3.84.
- If our calculated value is **higher** than 3.84, we reject the null hypothesis and accept the alternate hypothesis. This means that the observed data is significant and that it is due to some phenomena, not randomness.
- If our calculated value is **lower** than 3.84, we accept the null hypothesis and reject the alternate hypothesis. This means that the observed data is not significant and that it is due to randomness.
- The calculated value in the example above is 8.9. Do we accept or reject the null hypothesis?

For a slightly more involved explanation, see the video, “How to Perform a Chi-Square Test (By Hand)”.