

Chi-Squared Test for Association

Workshop

- There is evidence that the opinions of Americans on evolution have changed in the last few years. Here is data from Gallup comparing the results of two polls, one from 2001 and one from 2017. The counts are the number of people who agree with each of the statements.

	2001		2017		Total
Humans evolved with God's guidance	380	(37.4%)	384	(38.0%)	764
Humans evolved, God played no part	123	(12.1%)	192	(19.0%)	315
God created humans in their present form	462	(45.5%)	384	(38.0%)	846
Other/no opinion	51	(5.0%)	51	(5.0%)	102
Total	1016	(100%)	1011	(100%)	2027

- The column proportions are shown in parentheses in this table. Use them to make a stacked bar graph so you can see if there is a difference between opinions in 2001 and 2017.
 - Which categories have seen the biggest shifts in opinion since 2001?
 - The chi-squared test statistic for this table is $\chi^2 = 22.3$. Use the app to find the corresponding p-value and then explain what it means. Make sure to use degrees of freedom equal to $(\#columns - 1) \cdot (\#rows - 1)$.
- The General Social Survey asked people "In general how do you feel about your time? Do you always feel rushed, sometimes feel rushed, or almost never feel rushed?" The results of the survey in the two-way table below have $\chi^2 = 7.69$.

	Male	Female
Always	116	188
Sometimes	229	284
Never	82	78
Total	427	550

- Find the degrees of freedom and the p-value for the χ^2 -test, then explain what it means about whether there is a difference between how rushed men and women feel in the population.
- Who is more likely to always feel rushed, men or women?

3. The Stanford University Heart Transplant Study was conducted to determine whether an experimental heart transplant program increased lifespan. Each patient entering the program was officially designated a heart transplant candidate, meaning that he was gravely ill and might benefit from a new heart. Patients were randomly assigned into treatment and control groups. Patients in the treatment group received a transplant, and those in the control group did not. The table below displays how many patients survived and died in each group.

	Control	Treatment	Total
Survived	4	24	28
Died	30	45	75
Total	34	69	103

- (a) The chi-squared statistic for this table is $\chi^2 = 6.10$. What is the corresponding p-value? What does that mean about whether or not heart transplants work?
- (b) Because only 4 people survived in the control group, we might worry about whether or not the chi-squared test is trustworthy. We should check to see if the expected number of survivors in the control group is at least five. *Use the expected count formula to find out.*

$$E_{ij} = \frac{\text{Row total} \times \text{Column Total}}{\text{Table Total}}.$$

- (c) We could also have done a two-sample hypothesis test for proportions using the formula:

$$z = \frac{\hat{p}_T - \hat{p}_C}{\sqrt{\hat{p}(1 - \hat{p}) \left(\frac{1}{n_T} + \frac{1}{n_C} \right)}}.$$

What are \hat{p}_T and \hat{p}_C in this formula? What do the subscripts T and C mean?

- (d) The z -value in the formula above is $z = 2.47$. What is the corresponding (2-sided) p-value? How does it compare to the p-value from the χ^2 -test? (Hint: *Your answer is not a coincidence. The result of a χ^2 -test with one degree of freedom is always the same as the result of a two sample test for proportions.*)