

Chi-Square Test of Independence: A Step-by-Step Guide Using the TI-84 Calculator

Authored by
Mohammed loot

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Introduction to the Chi-Square Test of Independence

The [Chi-Square Test of Independence](#) stands as a cornerstone in inferential statistics, serving the critical function of evaluating the relationship between two distinct [categorical variables](#). This powerful test determines whether the distribution of outcomes across one variable is statistically independent of the distribution across the second variable. In essence, it helps researchers ascertain if there is a **statistically significant association** between the characteristics being measured, a necessity across disciplines ranging from epidemiology and psychology to comprehensive market analysis.

Understanding this statistical procedure is vital for anyone analyzing survey data or experimental outcomes where variables are classified into groups. The core mechanism involves comparing the frequencies observed in the collected data against the frequencies that would be theoretically **expected** if the two variables were truly unrelated. A large discrepancy between these observed and expected values suggests a strong association, leading to the rejection of the assumption of independence.

While the underlying mathematics can be complex, modern graphing calculators simplify the execution dramatically. This detailed guide focuses exclusively on leveraging the robust statistical capabilities of the [TI-84 Calculator](#). By following these precise steps, users can efficiently perform a Chi-Square Test of Independence, generating accurate results and the necessary metrics--such as the test statistic and the crucial p-value--required for rigorous hypothesis testing.

Case Study Setup: Gender and Political Party Preference

To provide a clear, practical context for the TI-84 procedure, we will employ a realistic scenario centered on political science research. Our objective is to determine if an individual's **gender** is associated with their declared **political party preference**. This investigation requires us to establish formal statistical hypotheses to test this association empirically.

The formal framework of hypothesis testing begins with the formulation of the hypotheses. The **null hypothesis** (H_0) always represents the status quo or the assumption of no effect; specifically, it asserts that gender and political preference are independent variables, meaning there is no association between them. Conversely, the alternative hypothesis (H_a) posits that the variables are dependent, suggesting that there is a statistically significant relationship.

Our study involves gathering primary data through a simple random sample of 500 eligible voters. Each participant was classified by gender (Male/Female) and party affiliation (Republican, Democrat, Independent). The resulting raw frequency data, which records the observed counts for every possible combination of these two [categorical variables](#), is meticulously organized into the following [contingency table](#). This table serves as the definitive source for the numerical input

required by the calculator's matrix function.

	Republican	Democrat	Independent	Total
Male	120	90	40	250
Female	110	95	45	250
Total	230	185	85	500

The subsequent steps will walk through the exact sequence of commands necessary on the [TI-84 Calculator](#) to utilize these **observed frequencies**, ultimately determining if the pattern of affiliation differs significantly enough across genders to reject the idea of independence.

Step 1: Data Entry and Matrix Configuration

The successful execution of the Chi-Square Test hinges entirely upon the accurate structuring and entry of the observed data into the calculator's dedicated matrix interface. This step translates the two-dimensional contingency table into a format the statistical processor can utilize. Any error in dimensions or cell values will render the final statistical result meaningless.

To access the necessary matrix functionality, press the **2nd** key, followed immediately by the **x-1** key, which is labeled MATRIX. Once the MATRIX menu appears, use the arrow keys to navigate horizontally to the **EDIT** tab. Select an empty matrix designation, typically Matrix , and press **Enter** to begin the editing process.

The first critical action within the matrix editor is defining the dimensions (Rows x Columns). Our contingency table contains 2 rows (Male, Female) and 3 columns (Republican, Democrat, Independent), excluding the total rows and columns. Therefore, the dimensions must be set precisely to 2x3. After setting the dimensions, sequentially input the raw frequency counts, moving strictly across the rows. It is essential to remember that only the cell frequencies (the counts corresponding to the intersections of categories) should be entered; the marginal totals (the "Total" row and column) are explicitly excluded from the matrix input, as they are used only for reference.

The image provided below serves as a visual confirmation of how the observed data from our case study should appear once correctly stored within Matrix . This matrix holds the data that represents the actual results of the survey, preparing the calculator to compare these results against the theoretical values generated under the assumption of the [null hypothesis](#).

MATRIX[A] 2 × 3		
120	90	40
110	95	45

Step 2: Executing the Statistical Test (X²-Test)

With the observed data successfully stored in Matrix , the next phase involves instructing the calculator to run the appropriate statistical test. The [Chi-Square Test of Independence](#) is a built-in function of the TI-84, ensuring rapid and accurate calculation of the test statistics.

Initiate the process by pressing the **stat** key. Use the right arrow key to navigate to the **TESTS** menu, which lists all available inferential statistical procedures. Scroll down through this list until you locate the **X²-Test** option. This specific test is designed to handle the analysis of two-way frequency tables for independence. Press **Enter** to select the function and view the setup screen.

The setup screen requires two crucial pieces of information: the location of the **Observed** frequencies and the location where the calculated **Expected** frequencies should be stored. For **Observed**, ensure that Matrix (or whichever matrix you used in Step 1) is selected. For **Expected**, select an unused matrix, typically Matrix . It is fundamentally important to understand that the calculator handles the complex calculation of the expected values automatically, based on the marginal totals derived from Matrix , assuming the condition of independence holds true. The user is not required to calculate these expected values manually.

EDIT CALC TESTS
6: 2-PropZTest...
7: ZInterval...
8: TInterval...
9: 2-SampZInt...
0: 2-SampTInt...
A: 1-PropZInt...
B: 2-PropZInt...
C : X ² -Test...

After verifying that the matrix inputs are correct, scroll down, highlight the **Calculate** option, and press **Enter**. The [TI-84 Calculator](#) will immediately process the data, compare the observed counts with the expected counts, and display the comprehensive results screen containing the metrics

necessary for hypothesis decision-making.

Step 3: Interpreting Results and Drawing Conclusions

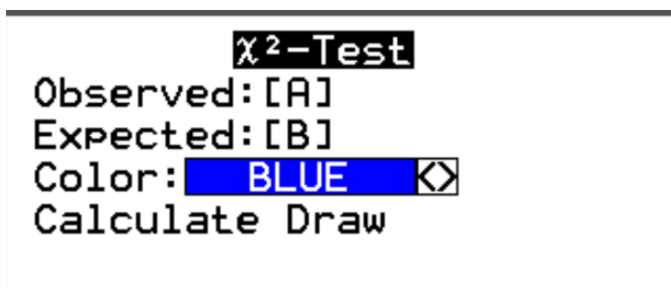
The final output screen provides the summary statistics essential for evaluating the strength of the evidence against the [null hypothesis](#). A precise understanding of each element of this output is necessary to reach a valid statistical conclusion about the relationship between gender and political party preference.

The key statistics displayed on the TI-84 results screen are:

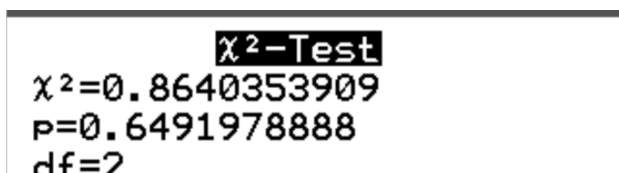
X²: This is the calculated [Chi-Square test statistic](#). It quantifies the overall magnitude of the difference between the **observed frequencies** (Matrix) and the **expected frequencies** (Matrix). A larger X² value suggests a greater departure from independence.

p: The associated [p-value](#). This probability represents the likelihood of observing data as extreme as, or more extreme than, the current sample data, assuming the null hypothesis of independence is true.

df: The degrees of freedom for the test. Calculated as (R-1)(C-1), where R is the number of rows (2) and C is the number of columns (3), resulting in $df = (2-1)(3-1) = 2$. The degrees of freedom determine the shape of the Chi-Square distribution used for calculating the p-value.



For our case study, the calculator generated the following specific values, as shown in the output summary:



We observe that the **X² test statistic** is approximately **0.8640**, and the corresponding [p-value](#) is **0.6492**. To conclude the hypothesis test, we compare this p-value against a predetermined

significance level (alpha, conventionally set at 0.05). The decision rule is straightforward: if the p-value is less than or equal to alpha, we reject H_0 ; otherwise, we fail to reject H_0 .

Since the calculated p-value (0.6492) is substantially **greater than the significance level** (0.05), we must **fail to reject the [null hypothesis](#)**. Statistically, this means that the observed differences in political preference between genders are not large enough to be considered statistically significant at the 5% level. We conclude that we do not have sufficient evidence to assert that a statistically significant association exists between gender and political party preference; therefore, these two [categorical variables](#) are deemed independent based on this sample data.