Null Hypothesis Overview

The **null hypothesis**, H0 is the commonly accepted fact; it is the opposite of the [alternate hypothesis](https://www.statisticshowto.com/what-is-an-alternate-hypothesis/). Researchers work to reject, nullify or disprove the null hypothesis. Researchers come up with an alternate hypothesis, one that they think explains a phenomenon, and then work to [reject the null hypothesis](https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/support-or-reject-null-hypothesis/).

Why is it Called the “Null”?

The word “null” in this context means that it’s a commonly accepted fact that researchers work to *nullify*. It doesn’t mean that the statement is null (i.e. amounts to nothing) itself! (Perhaps the term should be called the “nullifiable hypothesis” as that might cause less confusion).

## Type I error

A Type I error means rejecting the null hypothesis when it’s actually true. It means concluding that results are **statistically significant**when, in reality, they came about purely by chance or because of unrelated factors.

The risk of committing this error is the [significance level](https://www.scribbr.com/frequently-asked-questions/what-is-statistical-significance/) (alpha or α) you choose. That’s a value that you set at the beginning of your study to assess the statistical probability of obtaining your results ([p value](https://www.scribbr.com/statistics/p-value/)).

The significance level is usually set at 0.05 or 5%. This means that your results only have a 5% chance of occurring, or less, if the null hypothesis is actually true.

**/\*If the p value of your test is lower than the significance level, it means your results are statistically significant and consistent with the alternative hypothesis. If your p value is higher than the significance level, then your results are considered statistically non-significant.\*/**

Example: Statistical significance and Type I error. In your clinical study, you compare the symptoms of patients who received the new drug intervention or a control treatment. Using a [*t*test](https://www.scribbr.com/statistics/t-test/), you obtain a *p* value of .035. This *p* value is lower than your alpha of .05, so you consider your results statistically significant and reject the null hypothesis.

However, the *p* value means that there is a 3.5% chance of your results occurring if the null hypothesis is true. Therefore, there is still a risk of making a Type I error.

### Type I error rate

The null hypothesis distribution curve below shows the probabilities of obtaining all possible results if the study were repeated with new samples and the null hypothesis were true in the [population](https://www.scribbr.com/methodology/population-vs-sample/).

At the tail end, the shaded area represents alpha. It’s also called a **critical region** in statistics.

If your results fall in the critical region of this curve, they are considered statistically significant and the null hypothesis is rejected. However, this is a false positive conclusion, because the null hypothesis is actually true in this case!

**Type II error**

A Type II error means not rejecting the null hypothesis when it’s actually false.

Instead, a Type II error means failing to conclude there was an effect when there actually was. In reality, your study may not have had enough [**statistical power**](https://www.scribbr.com/statistics/statistical-power/) to detect an effect of a certain size.

Power is the extent to which a test can correctly detect a real effect when there is one. A power level of 80% or higher is usually considered acceptable.

The risk of a Type II error is inversely related to the statistical power of a study. The higher the statistical power, the lower the probability of making a Type II error.

Example: Statistical power and Type II errorWhen preparing your clinical study, you complete a power analysis and determine that with your sample size, you have an 80% chance of detecting an [effect size](https://www.scribbr.com/statistics/effect-size/) of 20% or greater. An effect size of 20% means that the drug intervention reduces symptoms by 20% more than the control treatment.

However, a Type II may occur if an effect that’s smaller than this size. A smaller effect size is unlikely to be detected in your study due to inadequate statistical power.

No hypothesis test is 100% certain. Because the test is based on probabilities, there is always a chance of making an incorrect conclusion. When you do a hypothesis test, two types of errors are possible: type I and type II. The risks of these two errors are inversely related and determined by the level of significance and the power for the test. Therefore, you should determine which error has more severe consequences for your situation before you define their risks.

**Type I error**

When the null hypothesis is true and you reject it, you make a type I error. The probability of making a type I error is α, which is the level of significance you set for your hypothesis test. An α of 0.05 indicates that you are willing to accept a 5% chance that you are wrong when you reject the null hypothesis. To lower this risk, you must use a lower value for α. However, using a lower value for alpha means that you will be less likely to detect a true difference if one really exists.

**Type II error**

When the null hypothesis is false and you fail to reject it, you make a type II error. The probability of making a type II error is β, which depends on the power of the test. You can decrease your risk of committing a type II error by ensuring your test has enough power. You can do this by ensuring your sample size is large enough to detect a practical difference when one truly exists.

The probability of rejecting the null hypothesis when it is false is equal to 1–β. This value is the power of the test.

# **TEST STATISTICS= |-1.1|= 1.1 > C.V = 0.9**

**REJECT Ho: means Test is “Statistically Significant”**

**Fail to Reject Ho: Test is “Statistically Non- Significant”**

# **WHENEVER WE’LL PERFORM ANY TEST, WE’LL GET A “*TEST STATISTICS”* FOR THAT PARTICULAR TEST.**

IN CASE OF CHI SQAURE, WE’LL GET THE CHISQUARE VALUE,

IN CASE OF T-TEST WE’LL GET THE T-VALUE etc.

IF THAT PARTICULAR VALUE OF THE RESPECTIVE STATISTICAL TEST IS GREATER THAN THE “*CRITICAL VALUE/TABLE* *VALUE* “THAN WE’LL REJECT THE H0.

ELSE WE FAIL TO REJECT THE H0

* FOR 95% CL
* α= 1- CL(in %) = 1- 0.95 = 0.05
* FOR 99% CL
* α= 1- CL(in %) = 1- 0.99 = 0.01
* FOR 90% CL
* α= 1- CL(in %) = 1- 0.90 = 0.10

(99) < 95 < 90

(Sig.) Sig. Sig.

IF THE TEST VALUE IS SIGNIFICANT AT 99% CL THAN IT WILL BE SIGNIFICANT AT 95% AND 90% CL. HOWEVER, VICEVERSE IS NOT TRUE

# **What is a critical value?**

In hypothesis testing, a critical value is a point on the test distribution that is compared to the test statistic to determine whether to reject the null hypothesis. If the absolute value of your test statistic is greater than the critical value, you can declare statistical significance and reject the null hypothesis. Critical values correspond to α, so their values become fixed when you choose the test's α.

Diagram

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###### **Figure A**

Diagram

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###### **Figure B**

###### Critical values on the standard normal distribution for **α** = 0.05

## Why do we have to use

## sigma / sqrt(n) ?(Standard Error)

**When you are estimating the**[**standard error**](https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/what-is-the-standard-error-of-a-sample/)**, SE, for the**[**mean**](https://www.statisticshowto.com/mean/)**(the SE is the standard deviation of the means of samples), the larger your**[**sample size**](https://www.statisticshowto.com/probability-and-statistics/find-sample-size/)**, the smaller the standard deviation difference between the sample and the population. for example, if you took a sample of 200, you would be much more likely to get close to the true mean than if you took a sample of 2.**

## Standard Error: σ/ √ n

## Margin of Error(Error Bound Mean): Z α \* σ/ √ n

## Confidence Interval: X̅ ± Z α \* σ/√ n

## X̅ - Z α \* σ/√ n ≤ µ ≤ X̅ + Z α \* σ/√ n

## AL = (1+ C.L)/2

## What is a Margin of Error?(Error Bound Mean)

A **margin of error** tells you **how many percentage points your results will differ**from the real population value. For example, a 95% [confidence interval](https://www.statisticshowto.com/probability-and-statistics/confidence-interval/) with a 4 percent margin of error means that your [statistic](https://www.statisticshowto.com/statistic/)will be within 4 percentage points of the real population value 95% of the time.

However, there’s a little more to the formal definition. The **margin of error**is defined a the [range](https://www.calculushowto.com/types-of-functions/domain-and-range-of-a-function/)of values below and above the [sample statistic](https://www.statisticshowto.com/sample-statistic-definition-examples/) in a [confidence interval](https://www.statisticshowto.com/probability-and-statistics/confidence-interval/). The confidence interval is a way to show what the [**uncertainty**](https://www.statisticshowto.com/uncertainty-in-statistics/) is with a certain [statistic](https://www.statisticshowto.com/statistic/)(i.e. from a poll or survey).

For example, a poll might state that there is a 98% confidence interval of 4.88 and 5.26. So we can say that if the poll is repeated using the same techniques, 98% of the time the true population parameter ([parameter vs. statistic](https://www.statisticshowto.com/statistics-basics/how-to-tell-the-difference-between-a-statistic-and-a-parameter/)) will fall within the interval estimates (i.e. between 4.88 and 5.26) 98% of the time.

Text

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Text, arrow

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Diagram

Description automatically generated with medium confidence

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A picture containing diagram

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Diagram, schematic

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## Margin of Error for a Proportion

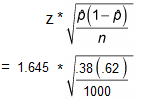
The formula is a little different for proportions:  
[moe](https://www.statisticshowto.com/wp-content/uploads/2013/08/moe.png)  
  
  
Where:

* [phat](https://www.statisticshowto.com/wp-content/uploads/2009/10/phat.bmp)= sample proportion (“P-hat”),
* n = sample size,
* z = z-score.

**Example question:** 1000 people were surveyed and 380 thought that climate change was not caused by human pollution. Find the MoE for a 90% confidence interval.

Step 1: **Find P-hat** by dividing the number of people who responded positively. “Positively” in this sense doesn’t mean that they gave a “Yes” answer; It means that they answered according to the statement in the question. In this case, 380/1000 people (38%) responded positively.

Step 2: **Find the z-score that goes with the given confidence interval.** But, you’ll need to reference [this chart of common critical values.](https://www.statisticshowto.com/probability-and-statistics/find-critical-values/#CommonCI) A 90% confidence interval has a z-score (a critical value) of 1.645.

Step 3: **Insert the values into the formula and solve:**  
[](https://www.statisticshowto.com/wp-content/uploads/2013/08/moep-2.png)

= 1.645 \* 0.0153

= 0.0252

Step 4: **Turn Step 3 into a percentage**:

0.0252 = 2.52%

In conclusion, the margin of error is 2.52%.

Ha: There exists a statistically significant association between Year and Student’s Category.

Ho: There exists no statistically significant association between Year and Student’s Category.

Conclusion: As we find out that the calculated Chi Square value is greater than the table value(critical value) at 95% CI, so we reject the Null Hypothesis and conclude that there exists a statistically significant association between Year and Student’s Category.

Dof: (N-1)\*(N-1)= (5-1)\*(5-1) = 16

95% CI: alpha= 1-0.95 = 0.05

Look into the critical value table of Chi Square, you’ll get the value of 26.3, which is less than 46.781.