# **Binomial test / Exact Binomial Test**

The binomial test is used when an experiment has two possible outcomes (i.e. success/failure) *and* you have an idea about what the probability of success is.**A binomial test is run to see if observed test results differ from what was expected.**
**Example**: you theorize that 75% of physics students are male. You survey a random sample of 12 physics students and find that 7 are male. Do your results significantly differ from the expected results?

**Solution**: Use the binomial formula to find the probability of getting your results. The [null hypothesis](https://www.statisticshowto.com/probability-and-statistics/null-hypothesis/) for this test is that your results do not differ significantly from what is expected.

Out of the two possible events, you want to solve for the event that gave you the *least expected result*. You expected 9 males (i.e. 75% of 12), but got 7, so for this example solve for 7 or fewer students.


**Note**: you can find a step by step example of how to solve the equation [here in the Binomial Formula article.](https://www.statisticshowto.com/probability-and-statistics/binomial-theorem/binomial-distribution-formula/)

* p, the observed proportion, is 7/12, or .47.
* q, (1 – p) is 1 – .47.
* X is your expected number of successes (75% of 12 is 9).

Plugging those values into the formula and solving, you get:
0.158, which is the probability of 7 or fewer males out of 12. Doubling this (for a [two tailed test](https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/one-tailed-test-or-two/)), gives 0.315. These are your [p-values](https://www.statisticshowto.com/p-value/). **With very few exceptions, you’ll always use the doubled value.**

As the p-value of 0.315 is large (I’m assuming a 5% [alpha level](https://www.statisticshowto.com/what-is-an-alpha-level/) here, which would mean p-values of less than 5% would be significant), you cannot [reject the null hypothesis](https://www.statisticshowto.com/support-or-reject-null-hypothesis/) that the results are expected. In other words, 7 is not outside of the range of what you would expect.

If, on the other hand, you had run the test with 4 males (p=.333 and q=.666), the doubled p-value would have been .006, which means you *would* have rejected the null.

**Assumptions for the Binomial Test**

1. Items are [dichotomous](https://www.statisticshowto.com/dichotomous-variable/)(i.e. there are two of them) and nominal.
2. The sample size is significantly less than the population size.
3. The sample is a fair representation of the population.
4. Sample items are independent (one item has no bearing on the probability of another).

The Binomial Test procedure compares the observed frequencies of the two categories of a dichotomous variable to the frequencies that are expected under a binomial distribution with a specified probability parameter. By default, the probability parameter for both groups is 0.5. To change the probabilities, you can enter a test proportion for the first group. The probability for the second group will be 1 minus the specified probability for the first group.

**Example.** When you toss a dime, the probability of a head equals 1/2. Based on this hypothesis, a dime is tossed 40 times, and the outcomes are recorded (heads or tails). From the binomial test, you might find that 3/4 of the tosses were heads and that the observed significance level is small (0.0027). These results indicate that it is not likely that the probability of a head equals 1/2; the coin is probably biased.

**Data.** The variables that are tested should be numeric and dichotomous. To convert string variables to numeric variables, use the Automatic Recode procedure, which is available on the Transform menu. A **dichotomous variable** is a variable that can take only two possible values: *yes* or *no*, *true* or *false*, 0 or 1, and so on. The first value encountered in the dataset defines the first group, and the other value defines the second group. If the variables are not dichotomous, you must specify a cut point. The cut point assigns cases with values that are less than or equal to the cut point to the first group and assigns the rest of the cases to the second group.

**Assumptions.** Nonparametric tests do not require assumptions about the shape of the underlying distribution. The data are assumed to be a random sample.