BigPicture

Big Picture: Number Crunching

# Chi-squared test worked example

## Data

A student investigated whether taking vitamin C tablets every day for a school term affected peoples' chances of getting a cold during the period. The results are shown below.

| | Vitamin C tablet taken | Vitamin C tablet not taken |
|---|---|---|
| Got a cold during the term | 15 | 22 |
| Did not get a cold during the term | 100 | 93 |

**Choose statistical test.**

The chi-square test is used when:

- data are nominal (in this case people either got a cold, or did not get a cold)
- the observed number in each category can be compared to an expected number
- none of the expected frequencies is less than five.

**State the null hypothesis**.

NH°: Vitamin C does not affect the chance of catching a cold.

**State the level of significance.**

P = 5 per cent (0.05).

**Calculate the expected results.**

Assuming the null hypothesis to be true, we would expect the proportion of people taking vitamin C tablets who caught a cold to be the same as the proportion of people not taking vitamin C tablets who caught a cold.

*Calculate the totals of the rows and columns in the results table.*

| | Vitamin C tablet taken | Vitamin C tablet not taken | Row total |
|---|---|---|---|
| Got a cold | 15 | 22 | 37 |
| Did not get a cold | 100 | 93 | 193 |
| Column total | 115 | 115 | 230 |

*Calculate the proportion of students who caught a cold.*

Proportion of students who got a cold = 37/230

= 0.16

*Calculate the number of students expected to catch a cold and not catch a cold in each sample.*

We would expect 16 per cent of students taking vitamin C to catch a cold: 18.4 students.
We would expect 84 per cent of students taking vitamin C to not catch a cold: 96.6 students.
We would expect 16 per cent of students not taking vitamin C to catch a cold: 18.4 students.
We would expect 84 per cent of students not taking vitamin C to not catch a cold: 96.6 students.

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**Calculate the chi-squared value.**

| Category | Observed (O) | Expected (E) | O–E | Yates' correction* (O–E)–0.5 | Square of corrected difference | Square of corrected difference/E |
|---|---|---|---|---|---|---|
| Took vitamin C, got cold | 15 | 18.4 | –3.4 | –3.9 | 15.21 | 0.827 |
| Took vitamin C, did not get cold | 100 | 96.6 | 3.4 | 2.9 | 8.41 | 0.087 |
| Did not take vitamin C, got cold | 22 | 18.4 | 3.6 | 3.1 | 9.61 | 0.522 |
| Did not take vitamin C, did not get cold | 93 | 96.6 | –3.6 | –4.1 | 16.81 | 0.174 |
| Total | | | | | | 1.61 |

$\chi^2 = 1.61$

*Yates' correction applies for a 2 x 2 table.

**What are the degrees of freedom?**

DF = (number of rows – 1) x (number of columns – 1)
DF = (2–1) x (2–1)
DF = 1

**Compare the calculated value with the critical value.**

| Degrees of freedom | Significance level | | |
|---|---|---|---|
| | 5% | 2% | 1% |
| 1 | 3.84 | 5.41 | 6.64 |
| 2 | 5.99 | 7.82 | 9.21 |

The critical value of chi-squared at 5% significance and 1 degree of freedom is **3.84**.
Our calculated value is **1.61**.
The calculated value is smaller than the critical value at the 5% level of probability.

## Conclusion

We cannot reject the null hypothesis, so there is not a significant difference between the observed and expected results at the 5 per cent level of probability.

Students taking vitamin C tablets do not have a significantly different chance of catching a cold compared to students not taking vitamin C tablets.