The **expected frequencies (*E)*** are calculated by multiplying the two relevant marginal totals (the row total and the column total) for a cell and dividing by the total number of participants N:

$$E = \frac{r * c}{N}$$

Chi-square is the sum of the squared differences between the observed and the expected frequencies, divided by the expected frequencies:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

The **degrees of freedom** for chi-square are calculated by multiplying the number of columns (*c)* minus 1 with the number of rows (*r*) minus 1:

$$df = (c - 1)(r - 1)$$

Step-by-step instructions for calculating chi-square:

1. Note the **observed frequency** in each cell.
2. Calculate the **expected frequency** for each cell by multiplying the two relevant marginal totals (the row total and the column total) for that cell and divide by the total number of participants in the sample.
3. Calculate **chi-square** (see formula above) by:
    a. Calculating the difference between the observed and the expected frequency for each cell and squaring that number;
    b. Dividing the result by the expected frequency for that cell.
4. Add up the results for all cells to acquire chi-square.
5. Determine the **degrees of freedom** by multiplying the number of columns minus 1 by the number of rows minus 1 (see formula above).
6. Look up the significance of chi-square in the table.

Table E Critical values of χ^2 at various levels of probability (chi-square)

For any particular *df* the observed value of χ^2 is significant at a given level of significance if it is *equal to* or *larger than* the critical values shown in the table.

df	*0.10*	*0.05*	*0.02*	*0.01*	*0.001*
1	2.71	3.84	5.41	6.64	10.83
2	4.60	5.99	7.82	9.21	13.82
3	6.25	7.82	9.84	11.34	16.27
4	7.78	9.49	11.67	13.28	18.46
5	9.24	11.07	13.39	15.09	20.52
6	10.64	12.59	15.03	16.81	22.46
7	12.02	14.07	16.62	18.48	24.32
8	13.36	15.51	18.17	20.09	26.12
9	14.68	16.92	19.68	21.67	27.88
10	15.99	18.31	21.16	23.21	29.59
11	17.28	19.68	22.62	24.72	31.26
12	18.55	21.03	24.05	26.22	32.91
13	19.81	22.36	25.47	27.69	34.53
14	21.06	23.68	26.87	29.14	36.12
15	22.31	25.00	28.26	30.58	37.70
16	23.54	26.30	29.63	32.00	39.29
17	24.77	27.59	31.00	33.41	40.75
18	25.99	28.87	32.35	34.80	42.31
19	27.20	30.14	33.69	36.19	43.82
20	28.41	31.41	35.02	37.57	45.32
21	29.62	32.67	36.34	38.93	46.80
22	30.81	33.92	37.66	40.29	48.27
23	32.01	35.17	38.97	41.64	49.73
24	33.20	36.42	40.27	42.98	51.18
25	34.38	37.65	41.57	44.31	52.62
26	35.56	38.88	42.86	45.64	54.05
27	36.74	40.11	44.14	46.97	55.48
28	37.92	41.34	45.42	48.28	56.89
29	39.09	42.56	46.69	49.59	58.30
30	40.26	43.77	47.96	50.89	59.70

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