

5.4c CHI² Test: Manual Calculations

The χ^2 test is a measure of independence between two variables.

It calculates the difference between calculated values and expected values.

The formula for the χ^2 test is as follows:

$$\chi^2_{calc} = \sum \frac{(f_o - f_e)^2}{f_e}$$

where f_o are the observed frequencies and f_e are the expected frequencies

This formula tells us to...

1. $f_o - f_e \rightarrow$ For every observed number in the table, Subtract the expected number.
2. $(f_o - f_e)^2 \rightarrow$ Square the differences.
3. $\frac{(f_o - f_e)^2}{f_e} \rightarrow$ Divide the squares obtained for each cell by the expected for that cell.
4. $\sum \rightarrow$ sum all of the values. ADD.

This is the χ^2 value.

A math studies project examines the relationship between the number of push-ups a person can do in one minute and the circumference of the person's biceps. Data were collected as follows:

Circumference of biceps in cm (x)	Number of push-ups (y)		
	$y < 20$	$20 \leq y < 50$	$y > 50$
$x < 28$ cm	12	18	22
$x \geq 28$ cm	19	16	14
	31	34	36

52
49
101

Determine at a 5% significance level whether or not the number of push-ups is independent of the circumference of the biceps.

H_0 : Bicep circumference and number of push-ups done in one minute are independent.

H_1 : Bicep circumference and number of push-ups completed in one minute are not independent.

Degrees of freedom: $(2-1)(3-1) = 2$

Expected values:

Circumference of biceps in cm (x)	Number of push-ups (y)		
	$y < 20$	$20 \leq y < 50$	$y > 50$
$x < 28$ cm	15.9604	17.5050	18.5347
$x \geq 28$ cm	15.0396	16.4950	17.4653

Calculate the χ^2 statistic:

$$\chi^2_{calc} = \sum \frac{(f_o - f_e)^2}{f_e}$$

Observed (f_o)	Expected (f_e)	$f_o - f_e$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
12	15.9604	-3.9604	15.6848	0.9827
18	17.5050	0.495	0.2450	0.01399
22	18.5347	3.4653	12.0083	0.6479
19	15.0396	3.9604	15.6848	1.0429
16	16.4950	-0.495	0.2450	0.0149
14	17.4653	-3.4653	12.0083	0.6876
Total				$\chi^2 = 3.389$

Homework: 242-244:1-10 all

