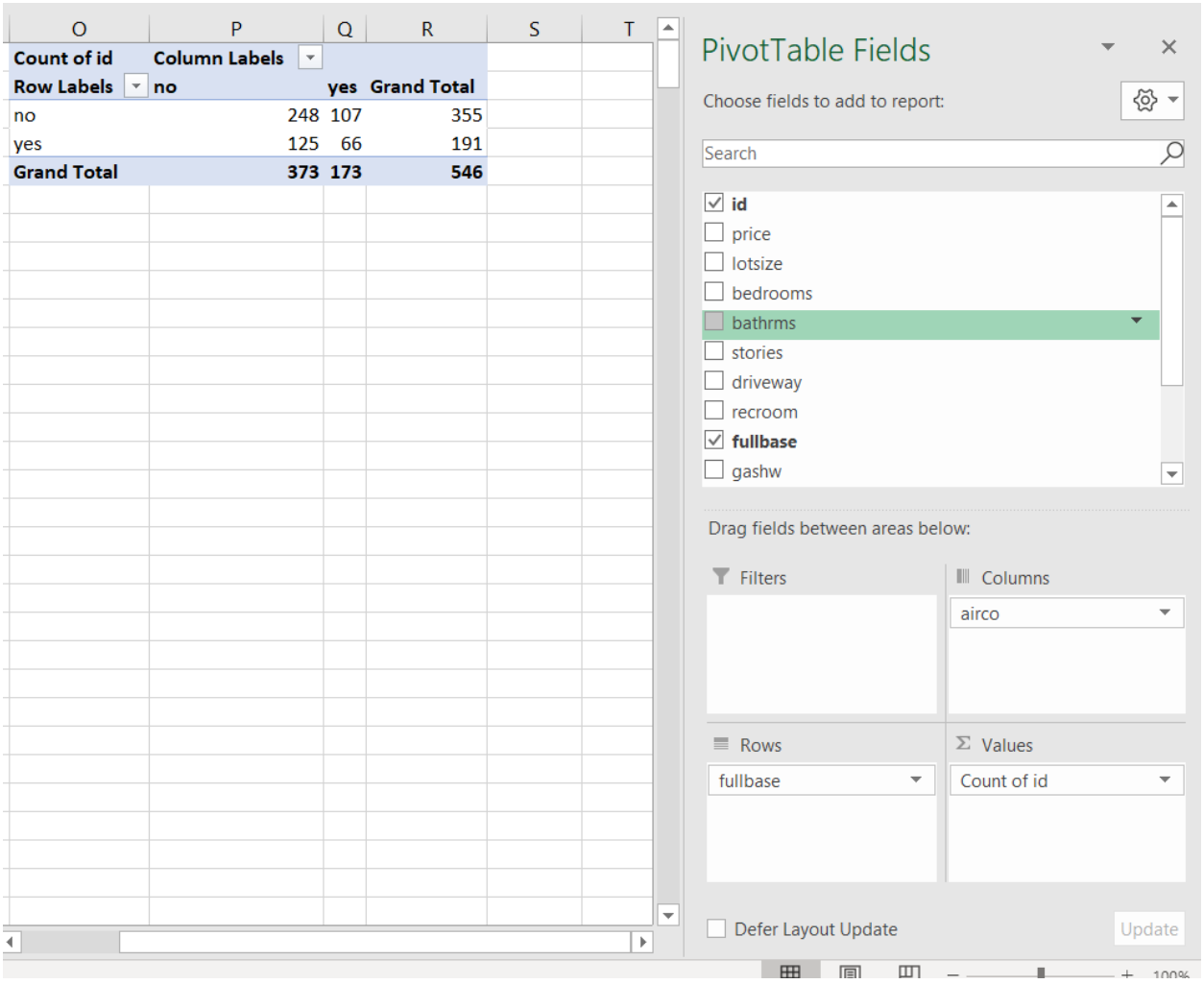
Expected values and repeated measures: demo notes

Chi-square test of independence

File: `housing.xlsx`

Is there a relationship between homes that have air conditioning and homes that have a full basement?

1. Insert a PivotTable from the source data. Place `airco` in the Columns section, `fullbase` in the Rows section, and count of `id` in the Values section.



2. These are our *actual* values. We will now calculate the *expected* values based on overall proportions. Copy and paste the data from the PivotTable and add formulas to sum the row and column totals.
   a. It can also be helpful to relabel the row and column headers to know exactly which category is which.

O	P	Q	R	S
Count of id	**Column Labels**			
Row Labels	**ac-no**	**ac-yes**	**Grand Total**	
fullbase-no	248	107	355	
fullbase-yes	125	66	191	
Grand Total	**373**	**173**	**546**	
Count of id	Column Labels			
Row Labels	ac-no	ac-yes	Grand Total	
fullbase-no	248	107	355	
fullbase-yes	125	66	191	
Grand Total	373	173	=SUM(R9,R10)	

3. We will now calculate what would be expected for each category based on a straight proportion.

Count of id	**Column Labels**			
Row Labels	**ac-no**	**ac-yes**	**Grand Total**	
fullbase-no	248	107	355	
fullbase-yes	125	66	191	
Grand Total	**373**	**173**	**546**	
Count of id	Column Labels			
Row Labels	ac-no	ac-yes	Grand Total	
fullbase-no	=($R$3*$P$5)/$R$5		355	
fullbase-yes	130.481685	60.51831502	191	
Grand Total	373	173	546	

4. We will now find the p-value of the chi-square test using the Excel function `CHISQ.TEST()`. The function takes two arguments: the first is the range of *actual* values (which come from the PivotTable), and the second from the *expected* (which we calculated).
   a. In this case, since the p-value exceeds .05, we fail to reject the null. There is no significant relationship between these categories.

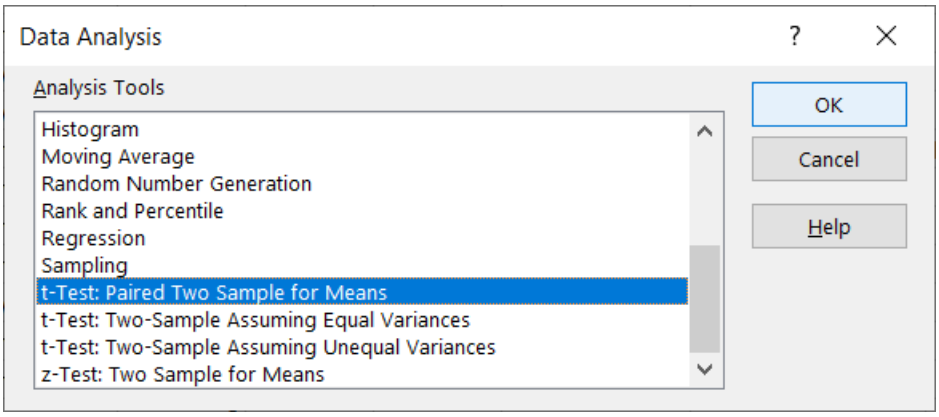
	O	P	Q	R	S
	Count of id	**Column Labels**			
	Row Labels	**ac-no**	**ac-yes**	**Grand Total**	
	fullbase-no	248	107	355	
	fullbase-yes	125	66	191	
	Grand Total	**373**	**173**	**546**	
	Count of id	Column Labels			
	Row Labels	ac-no	ac-yes	Grand Total	
	fullbase-no	242.518315	112.481685	355	
	fullbase-yes	130.481685	60.51831502	191	
	Grand Total	373	173	546	
	0.290378605	=CHISQ.TEST(P3:Q4,P9:Q10)			

Paired sample t-test

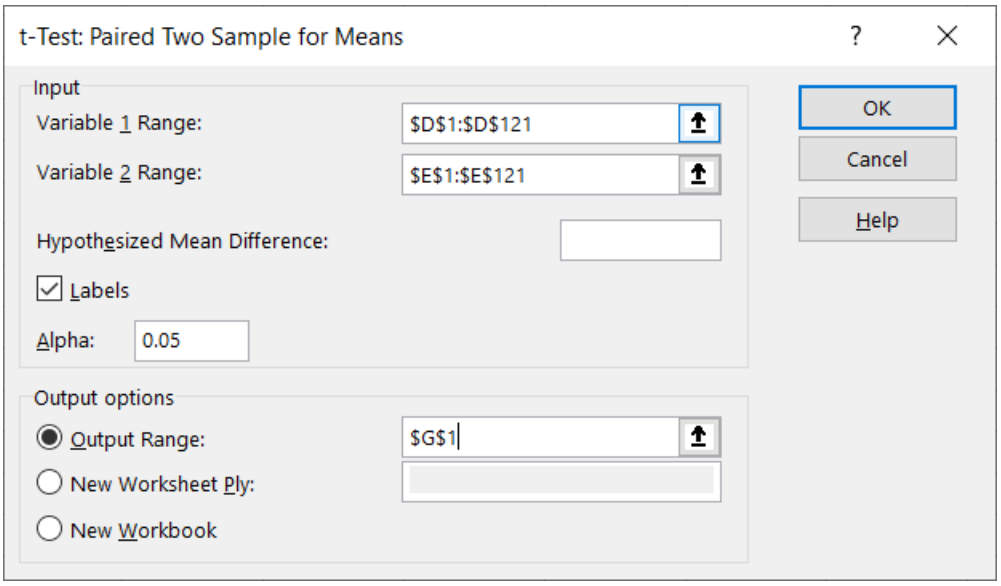
Demo: `bp.xlsx`

Is there a difference in blood pressures after the intervention?

1. For this test, we will use the Data Analysis ToolPak. Find the t-test: Paired Two Sample for Means option.



2. Select the measurements for Time 1 and Time 2. The Hypothesized Mean Difference will set to zero by default, which is what we want.



3. Based on the p-value for the two-tailed t-test, we reject the null. Blood pressures are significantly lower on average after the intervention.

t-Test: Paired Two Sample for Means		
	bp_before	*bp_after*
Mean	156.45	151.3583333
Variance	129.7285714	201.004972
Observations	120	120
Pearson Correlation	0.159118103	
Hypothesized Mean Difference	0	
df	119	
t Stat	3.337187051	
P(T<=t) one-tail	0.000564896	
t Critical one-tail	1.657759285	
P(T<=t) two-tail	0.001129791	
t Critical two-tail	1.980099876	

Wilcoxon signed-rank test

Demo: `cortisol.xlsx`

For this test, we will multiply the sign of each observation (+1 or -1) by the relative ranking of its absolute value, ranked ascending.

1. Enter the following formulas for columns D-F:

D	Sign	=SIGN(B3-C3)
E	Absolute value	=ABS(B3-C3)
F	Signed-rank	=RANK.AVG(E3,$E$3:$E$22,1)*D3

2. Now we take the sum of all positive and negative ranks, and find their absolute values:

	H	I	J	K	L	M	N
1							
2		Sum ranks	Absolute value				
3	Positive sum (Sum of all positive signed-ranks)	197	197	=SUMIF($F$3:$F$22,">0")	=ABS(I3)		
4	Negative sum (Sum of all negative signed-ranks)	-13	13	=SUMIF($F$3:$F$22,"<0")	=ABS(I4)		

3. Our test statistic is whatever of these two values is smaller, and our critical value is found from a lookup of the `critical-values` worksheet based on our sample size.

	H	I	J	K	L	M
1						
2		Sum ranks	Absolute value			
3	Positive sum (Sum of all positive signed-ranks)	197	197	=SUMIF($F$3:$F$22,">0")	=ABS(I3)	
4	Negative sum (Sum of all negative signed-ranks)	-13	13	=SUMIF($F$3:$F$22,"<0")	=ABS(I4)	
5						
6	Test statistic	13	=MIN(J3:J4)			
7	Critical value	52	=VLOOKUP(COUNT($A$3:$A$22),'critical-values'!$A$1:$B$22,2,FALSE)			
8						

4. If the test statistic is *less than* the critical value, we reject the null.

	H	I	J	K	L	M
1						
2		Sum ranks	Absolute value			
3	Positive sum (Sum of all positive signed-ranks)	197	197	=SUMIF($F$3:$F$22,">0")	=ABS(I3)	
4	Negative sum (Sum of all negative signed-ranks)	-13	13	=SUMIF($F$3:$F$22,"<0")	=ABS(I4)	
5						
6	Test statistic	13	=MIN(J3:J4)			
7	Critical value	52	=VLOOKUP(COUNT($A$3:$A$22),'critical-values'!$A$1:$B$22,2,FALSE)			
8	Reject the null?	Yes	=IF(I6<I7,"Yes","No")			
9						
10