

Two group hypothesis tests using Excel 2013 T-TEST command 1

## Two-Group Hypothesis Tests: Excel 2013 T-TEST Command

by  
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Slides and audio at: [www.StatLit.org/pdf/T-TEST-Command-Excel-2013-6up.pdf](http://www.StatLit.org/pdf/T-TEST-Command-Excel-2013-6up.pdf)

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## Excel T-TEST Command

**Purpose:** Calculate likelihood (p-value) of getting the observed difference in two sample means (or more extreme) by chance in random samples – assuming there is no difference in the two population means (the Null Hypothesis).

**Four Inputs:**

- 1) Array or range of two samples.
- 2) Alpha cutoff.
- 3) Tails: 1 (Excel matches Alternate with sample means) or 2.
- 4) Type of T-TEST. 1 dependent, matched subjects.  
2: population variances unknown but equal. [Often true]  
3: population variances unknown & unequal. [Conservative]

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## Use this data: B1:I241

Data for Q1-Q4 (B-E) is Binary: 0=No, 1=Yes.  
Data for Q5-Q6 (F-G) is Ordinal (discrete): 1-5.  
Data for Q7-Q8 (H-I) is Quantitative (ratio).

	A	B	C	D	E	F	G	H	I
1	ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
2	1	0	1	0	0	3	5	67	5
3	2	0	1	0	1	4	1	62	4
4	3	0	1	0	1	3	4	60	5
5	4	0	1	1	0	4	5	60	4
6	5	0	0	1	0	3	1	71	3

Excel instructions and data at:  
[www.StatLit.org/xls/2012Isaacson240Data.xls](http://www.StatLit.org/xls/2012Isaacson240Data.xls)

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## Approach

Excel's two-population T-Test command requires that the data be "stacked" (separated into two groups) by the value of the predictor. Predictor must be binary.

If the binary predictor is the answer to Q1, then *the entire data set* must be sorted by Q1.

The Excel "Sort" requires that the entire data set be selected **before** invoking the sort command. A common mistake is to sort just a single column rather than the entire dataset.

Unfortunately Excel does not have a "stacked" or conditional T-Test. The T-Test command will not automatically update p-values if data is changed.

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## A: From Data tab, select Sort

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## B: Select Sort Column/Order

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**C: Sort Data. Prepare column headings.**

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q2Q1=1	Q2Q1=0
1	1	1	0	0	0	5	1	75	7	
2	3	1	0	0	0	3	4	76	5	
3	3	1	0	0	0	3	4	76	5	
4	6	1	0	1	0	3	4	73	6	
5	7	1	0	0	0	4	1	72	6	
6	8	1	0	0	0	4	1	86	6	
7	9	1	0	0	0	4	3	90	6	
8	10	1	0	0	0	3	4	39	5	
9	11	1	0	0	0	5	2	40	4	
10	12	1	1	0	0	5	5	68	9	
11	13	1	1	1	1	5	1	71	8	
12	14	1	0	1	0	3	1	98	4	
13	15	1	1	0	1	3	1	80	7	
14	18	1	0	1	1	4	2	42	8	
15	19	1	0	0	0	3	3	39	6	
16	22	1	0	1	0	5	4	55	6	
17	23	1	1	0	0	4	2	74	6	
18	24	1	0	1	0	5	2	36	4	
19	26	1	1	1	1	5	2	49	7	
20	31	1	1	0	0	5	1	76	6	
21	32	1	0	0	0	3	1	92	4	
22	34	1	0	0	0	5	5	62	4	
23	35	1	0	0	0	5	4	54	7	
24	36	1	0	0	0	5	5	68	5	
25	38	1	1	0	1	5	5	60	6	
26	40	1	1	0	0	4	2	61	8	

Create headings that show what column or question is being tested and what column or question is used to split the data into two groups.

Q1 is used as the two-group splitter in this example. Any field with binary data can be used.

The vertical bar “|” means “given” so Q2|Q1=1 indicates the values of Q2 for which Q1 equals 1.

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**D: Copy stacked data to separate columns**

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q2Q1=1	Q2Q1=0	Q2Q1=1	Q2Q1=0	Q2Q1=1	Q2Q1=0
1	0	0	0	5	1	75	7	0	0	75	26	7	6
1	0	0	0	3	4	76	5	0	1	76	89	5	6
1	0	1	0	3	4	73	6	0	1	73	77	6	7
1	0	0	0	4	1	72	6	0	0	72	93	6	6
1	0	0	0	4	1	86	6	0	0	86	41	6	6
1	0	0	0	4	3	90	6	0	1	90	65	6	7
1	0	0	0	3	4	39	5	0	0	39	70	5	6
1	0	0	0	5	2	40	4	0	0	40	65	4	5
1	1	1	0	5	5	68	9	1	1	68	89	9	7
1	1	1	1	5	1	71	8	1	1	71	64	8	4
1	0	1	0	3	1	98	4	0	0	98	82	4	5
1	1	0	1	3	1	80	7	1	1	80	82	7	4
1	0	1	1	4	2	42	8	0	1	42	75	8	7
1	0	0	0	3	3	39	6	0	1	39	80	6	5
1	0	1	0	5	4	55	6	0	0	55	83	6	6
1	1	0	0	4	2	74	6	1	1	74	6	6	4
1	0	1	0	5	2	36	4	0	0	36	4	4	5
1	1	1	1	5	2	49	7	1	1	49	7	7	4
1	1	0	0	5	1	76	6	0	0	76	6	6	4
1	0	0	0	3	1	92	4	0	0	92	4	4	5
1	0	0	0	5	5	62	4	0	0	62	4	4	5
1	0	0	0	5	4	54	7	0	0	54	7	7	4
1	0	0	0	5	5	68	5	0	0	68	5	5	6
1	1	0	1	5	5	60	6	1	1	60	6	6	5
1	0	0	0	4	2	61	8	0	0	61	8	8	5
0	0	1	0	1	1	20	6	0	1	1	1	20	6

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**[E: If needed,] Enable Data-Analysis Toolpak**

If "Data Analysis" is not shown on Data tab, install it.

- Excel 2010/13: From File menu, select Options/Add-Ins.
- Excel 2008: From Microsoft button, select "Add Excel Options" in lower right corner.
- Excel 2003: If "Data Analysis Toolpak" is not shown under Tools menu, install it. From TOOLS menu, select ADD-INS.

Check the check box for "Data Analysis Toolpak". Press the OK command button. The Data Analysis command should be added to the appropriate menu. If not remove and reinstall.

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**T-TEST Command Procedure Given Separated Data**

- From Tool Menu, select "Data Analysis".
- From Data Analysis window, select "t-test: Two-sample with unequal variances".
- From associated window, enter inputs and outputs.
- Obtain results of t-test.

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**1) From the Data ribbon select Data Analysis**

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**2) Select T-Test Command: Two-Sample; Unequal Variances**

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### 3) Enter Input & Output: Q2 by Q1

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### 4) Excel-Generated Results: Q2 by Q1

t-Test: Two-Sample Assuming Unequal Variances		
	Q2 Q1=1	Q2 Q1=0
Mean	0.32	0.53
Variance	0.23	0.27
Observations	25	15
Hypothesized Mean Difference	0	
df	28	
t Stat	-1.30	
P(T<=t) one-tail	0.10	
t Critical one-tail	1.70	
P(T<=t) two-tail	0.20	
t Critical two-tail	2.05	

Difference in Q2 proportions by Q1 in not statistically significant  
 Technical: Fail to reject the null hypothesis for Q2 by Q1.

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### 3) Enter Input and Output: Q7 by Q1

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### 4) Excel-Generated Results: Q7 by Q1

t-Test: Two-Sample Assuming Unequal Variances		
	Q7 Q1=1	Q7 Q1=0
Mean	65.52	74.2
Variance	318.93	192.03
Observations	25	15
Hypothesized Mean Difference	0	
df	35	
t Stat	-1.72	
P(T<=t) one-tail	0.05	
t Critical one-tail	1.69	
P(T<=t) two-tail	0.09	
t Critical two-tail	2.03	

Difference in Q7 means by Q1 IS statistically significant (1 tail)  
 Technical: Reject the null hypothesis for Q7 by Q1 (1 tail)

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### 3) Enter Input and Output: Q8 by Q1

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### 4) Excel-Generated Results: Q8 by Q1

t-Test: Two-Sample Assuming Unequal Variances		
	Q8 Q1=1	Q8 Q1=0
Mean	6.00	5.80
Variance	2.00	1.03
Observations	25	15
Hypothesized Mean Difference	0	
df	37	
t Stat	0.52	
P(T<=t) one-tail	0.30	
t Critical one-tail	1.69	
P(T<=t) two-tail	0.61	
t Critical two-tail	2.03	

Difference in Q8 means by Q1 is NOT statistically significant.  
 Technical: Fail to reject the null hypothesis for Q8 by Q1

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**Summary**

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In a one-tailed test, T-TEST always tests whether the positive difference between the larger sample statistic and the smaller is statistically-significant.

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“Reject the null hypothesis” and “Failure to reject the null hypothesis” are technical conclusions.

“A difference IS [or IS NOT] statistically significant” is a less-technical conclusion.

Use the less-technical expressions for everyday communication.

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# Excel T-TEST Command

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**Purpose:** Calculate likelihood (p-value) of getting the observed difference in two sample means (or more extreme) by chance in random samples – assuming there is no difference in the two population means (the Null Hypothesis).

## Four Inputs:

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	A	B	C	D	E	F	G	H	I
1	ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
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3	2	0	1	0	1	4	1	62	4
4	3	0	1	0	1	3	4	60	5
5	4	0	1	1	0	4	5	60	4
6	5	0	0	1	0	3	1	71	3

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# Approach

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Excel's two-population T-Test command requires that the data be “stacked” (separated into two groups) by the value of the predictor. Predictor must be binary.

If the binary predictor is the answer to Q1, then *the entire data set* must be sorted by Q1.

The Excel “Sort” requires that the entire data set be selected **before** invoking the sort command. A common mistake is to sort just a single column rather than the entire dataset.

Unfortunately Excel does not have a “stacked” or conditional T-Test. The T-Test command will not automatically update p-values if data is changed.



## A: From Data tab, select Sort

Excel 2013 ribbon showing the DATA tab selected. The ribbon includes FILE, HOME, INSERT, PAGE LAYOUT, FORMULAS, DATA, and F. The DATA tab is active, showing options for Get External Data (From Access, From Web, From Text, From Other Sources), Existing Connections, Refresh All, Connections, Properties, and Edit Links. The Sort button is highlighted in the DATA tab.

The spreadsheet data is as follows:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8				
2	1	1	0	0	0	5	1	75	7				
3	2	0	0	1	0	1	1	58	6				
4	3	1	0	0	0	3	4	76	5				
5	4	0	1	1	1	3	2	89	6				
6	5	0	1	1	1	4	4	77	7				
7	6	1	0	1	0	3	4	73	6				
8	7	1	0	0	0	4	1	72	6				
9	8	1	0	0	0	4	1	88	6				
10	9	1	0	0	0	4	3	90	6				

## B: Select Sort Column/Order

The screenshot shows an Excel spreadsheet with a data table and a Sort dialog box. The data table has the following values:

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	1	0	0	0	5	1	75	7
2	0	0	1	0	1	1	58	6
3	1	0	0	0	3	4	76	5
4	0	1	1	1	3	2	89	6
21	0	0	0	0	4	2	70	8
22	1	0	1	0	5	4	55	6
23	1	1	0	0	4	2	74	6
24	1	0	1	0	5	2	36	4
25	0	0	1	0	4	4	65	5
26	1	1	1	1	5	2	49	7

The Sort dialog box is open, showing the following configuration:

- Column: Q1
- Sort On: Values
- Order: Largest to Smallest
- My data has headers:

## **C: Sort Data.**

### **Prepare column headings.**

	A	B	C	D	E	F	G	H	I	J	K	L
1	ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8		Q2 Q1=1	Q2 Q1=0
2	1	1	0	0	0	5	1	75	7			
3	3	1	0	0	0	3	4	76	5			
4	6	1	0	1	0	3	4	73	6			
5	7	1	0	0	0	4	1	72	6			
6	8	1	0	0	0	4	1	88	6			
7	9	1	0	0	0	4	3	90	6			
8	10	1	0	0	0	3	4	39	5			
9	11	1	0	0	0	5	2	40	4			
10	12	1	1	1	0	5	5	68	9			
11	13	1	1	1	1	5	1	71	8			
12	14	1	0	1	0	3	1	98	4			
13	15	1	1	0	1	3	1	80	7			
14	18	1	0	1	1	4	2	42	8			
15	19	1	0	0	0	3	3	39	6			
16	22	1	0	1	0	5	4	55	6			
17	23	1	1	0	0	4	2	74	6			
18	24	1	0	1	0	5	2	36	4			
19	26	1	1	1	1	5	2	49	7			
20	31	1	1	0	0	5	1	76	6			
21	32	1	0	0	0	3	1	92	4			
22	34	1	0	0	0	5	5	62	4			
23	35	1	0	0	0	5	4	54	7			
24	36	1	0	0	0	5	5	68	5			
25	38	1	1	0	1	5	5	60	6			
26	40	1	1	0	0	4	2	61	8			

Create headings that show what column or question is being tested and what column or question is used to split the data into two groups.

Q1 is used as the two-group splitter in this example. Any field with binary data can be used.

The vertical bar “|” means “given” so Q2|Q1=1 indicates the values of Q2 for which Q1 equals 1.

## D: Copy stacked data to separate columns

Q1=1

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8		Q2 Q1=1	Q2 Q1=0	Q7 Q1=1	Q7 Q1=0	Q8 Q1=1	Q8 Q1=0
1	0	0	0	5	1	75	7		0	0	75	58	7	6
1	0	0	0	3	4	76	5		0	1	76	89	5	6
1	0	1	0	3	4	73	6		0	1	73	77	6	7
1	0	0	0	4	1	72	6		0	0	72	93	6	6
1	0	0	0	4	1	88	6		0	0	88	41	6	6
1	0	0	0	4	3	90	6		0	1	90	65	6	7
1	0	0	0	3	4	39	5		0	0	39	70	5	6
1	0	0	0	5	2	40	4		0	0	40	65	4	5
1	1	1	0	5	5	68	9		1	1	68	89	9	7
1	1	1	1	5	1	71	8		1	1	71	64	8	4
1	0	1	0	3	1	98	4		0	0	98	82	4	5
1	1	0	1	3	1	80	7		1	1	80	82	7	4
1	0	1	1	4	2	42	8		0	1	42	75	8	7
1	0	0	0	3	3	39	6		0	1	39	80	6	5
1	0	1	0	5	4	55	6		0	0	55	83	6	6
1	1	0	0	4	2	74	6		1		74		6	
1	0	1	0	5	2	36	4		0		36		4	
1	1	1	1	5	2	49	7		1		49		7	
1	1	0	0	5	1	76	6		1		76		6	
1	0	0	0	3	1	92	4		0		92		4	
1	0	0	0	5	5	62	4		0		62		4	
1	0	0	0	5	4	54	7		0		54		7	
1	0	0	0	5	5	68	5		0		68		5	
1	1	0	1	5	5	60	6		1		60		6	
1	1	0	0	4	2	61	8		1		61		8	
0	0	1	0	1	1	58	6							
0	1	1	1	3	2	89	6							

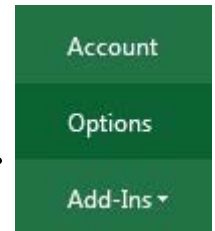
Q1=0.

## **[E: If needed,] Enable Data-Analysis Toolpak**

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If "Data Analysis" is not shown on Data tab, install it.

- Excel 2010/13: From File menu, select Options/Add-Ins.
- Excel 2008: From Microsoft button, select "Add Excel Options" in lower right corner.
- Excel 2003 If "Data Analysis Toolpak" is not shown under Tools menu, install it. From TOOLS menu, select ADD-INS.



Check the check box for "Data Analysis Toolpak". Press the OK command button. The Data Analysis command should be added to the appropriate menu. If not remove and reinstall.

# **T-TEST Command Procedure Given Separated Data**

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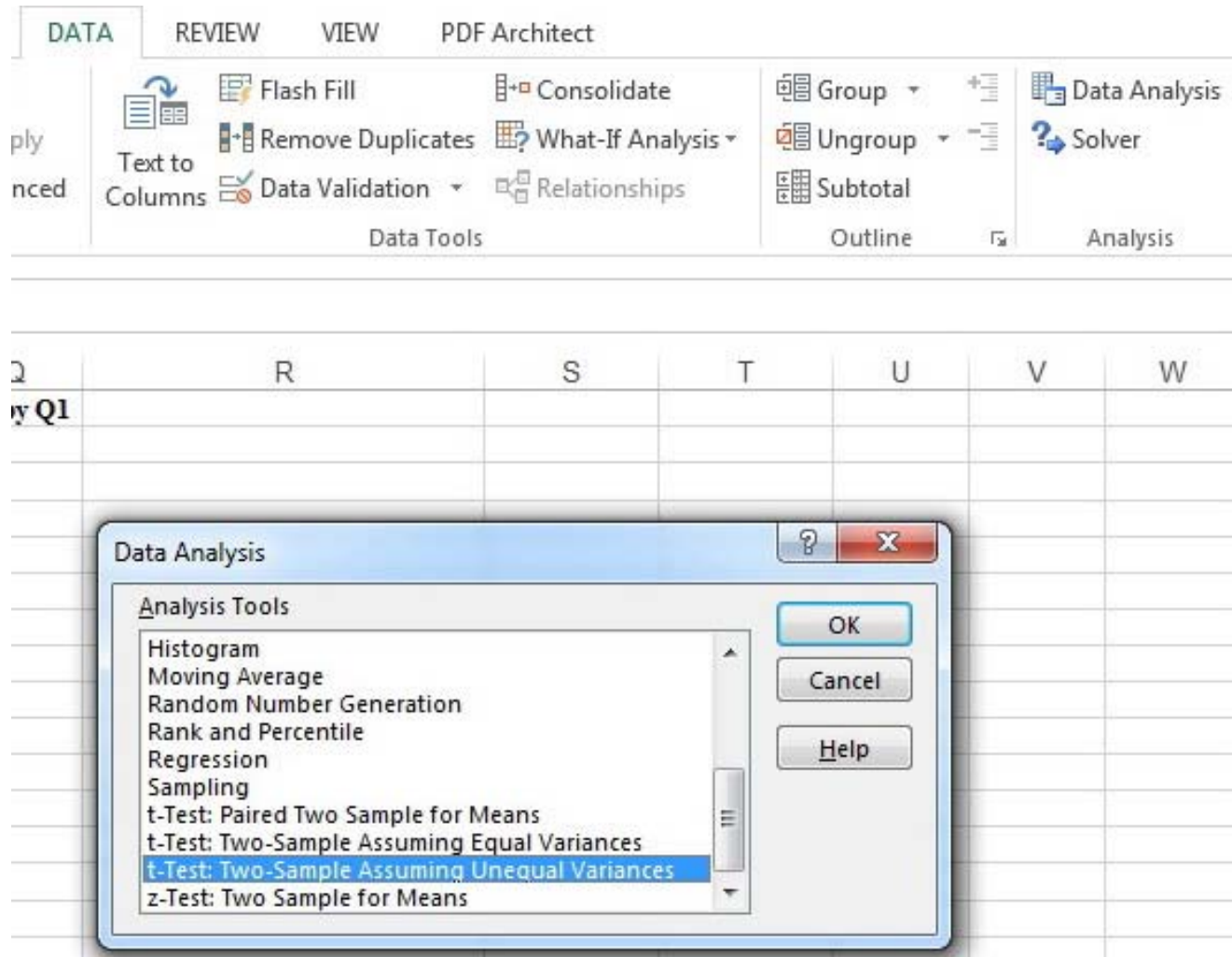
- 1: From Tool Menu, select “Data Analysis”.
- 2: From Data Analysis window, select “t-test: Two-sample with unequal variances”.
- 3: From associated window, enter inputs and outputs.
4. Obtain results of t-test.

# 1) From the Data ribbon select Data Analysis

The screenshot shows the Microsoft Excel 2013 interface. The 'DATA' ribbon is active, and the 'Data Analysis' button is highlighted. A dropdown menu is open, showing 'Data Analysis Tools' and 'FUNCRES.XLAM'. The spreadsheet data is as follows:

	K	L	M	N	O	P
1	Q2 Q1=1	Q2 Q1=0	Q7 Q1=1	Q7 Q1=0	Q8 Q1=1	Q8 Q1=0
2	0	0	75	58	7	6
3	0	1	76	89	5	6
4	0	1	73	77	6	7
5	0	0	72	93	6	6
6	0	0	88	41	6	6

## 2) Select T-Test Command: Two-Sample; Unequal Variances





## 3) Enter Input & Output: Q2 by Q1

K	L	M	N	O	P	Q	R
Q2/Q1=1	Q2/Q1=0	Q7/Q1=1	Q7/Q1=0	Q8/Q1=1	Q8/Q1=0	Q2 by Q1	
0	0	75	58	7	6		
0	1	76	89	5	6		
0	1						
0	0						
0	1						
0	0						
0	0						
1	1						
1	1						
0	0						
1	1						
0	1						
0	1						
0	0						
1							
0							
1							
1							
0		92		4			
0		62		4			
0		54		7			
0		68		5			
1		60		6			
1		61		8			

t-Test: Two-Sample Assuming Unequal Variances

Input

Variable 1 Range:

Variable 2 Range:

Hypothesized Mean Difference:

Labels

Alpha:

Output options

Output Range:

New Worksheet Ply:

New Workbook

OK Cancel Help

## 4) Excel-Generated Results: Q2 by Q1

t-Test: Two-Sample Assuming Unequal Variances		
	Q2 Q1=1	Q2 Q1=0
Mean	0.32	0.53
Variance	0.23	0.27
Observations	25	15
Hypothesized Mean Difference	0	
df	28	
t Stat	-1.30	
P(T<=t) one-tail	0.10	
t Critical one-tail	1.70	
P(T<=t) two-tail	0.20	
t Critical two-tail	2.05	

Difference in Q2 proportions by Q1 is not statistically significant  
 Technical: Fail to reject the null hypothesis for Q2 by Q1.

## 3) Enter Input and Output: Q7 by Q1

M	N	O	P	Q	R	S
Q7	Q1=1	Q7	Q1=0			
75		58				
76		89				
73		77				
72		93				
88		41				
90		65				
39		70				
40		65				
68		89				
71		64				
98		82				
80		82				
42		75				
39		80				
55		83				
74		0				
36		4		Q7 by Q1		
49		7				
76		6				
92		4				
62		4				
54		7				
68		5				
60		6				
61		8				

**t-Test: Two-Sample Assuming Unequal Variances**

**Input**

Variable 1 Range:

Variable 2 Range:

Hypothesized Mean Difference:

Labels

Alpha:

**Output options**

Output Range:

New Worksheet Ply:

New Workbook

OK Cancel Help

## 4) Excel-Generated Results: Q7 by Q1

Q7 by Q1			
t-Test: Two-Sample Assuming Unequal Variances			
		Q7 Q1=1	Q7 Q1=0
Mean		65.52	74.2
Variance		318.93	192.03
Observations		25	15
Hypothesized Mean Difference		0	
df		35	
t Stat		-1.72	
P(T<=t) one-tail		0.05	
t Critical one-tail		1.69	
P(T<=t) two-tail		0.09	
t Critical two-tail		2.03	

Difference in Q7 means by Q1 IS statistically significant (1 tail)

Technical: Reject the null hypothesis for Q7 by Q1 (1 tail)

## 3) Enter Input and Output: Q8 by Q1

O	P	Q	R	S	T	U
Q8:Q1=1	Q8:Q1=0					
7	6					
5	6					
6	7					
6	6					
6	6					
6	7					
5	6					
4	5					
9	7					
8	4					
4	5					
7	4					
8	7					
6	5					
6	6					
6						
4						
7						
6						
4		Q8 by Q1				
4						
7						
5						
6						
8						

t-Test: Two-Sample Assuming Unequal Variances

Input

Variable 1 Range: \$O\$1:\$O\$26

Variable 2 Range: \$P\$1:\$P\$16

Hypothesized Mean Difference: 0

Labels

Alpha: 0.05

Output options

Output Range: \$R\$21

New Worksheet Ply:

New Workbook

OK Cancel Help

## 4) Excel-Generated Results: Q8 by Q1

Q8 by Q1 t-Test: Two-Sample Assuming Unequal Variances			
		Q8 Q1=1	Q8 Q1=0
Mean		6.00	5.80
Variance		2.00	1.03
Observations		25	15
Hypothesized Mean Difference		0	
df		37	
t Stat		0.52	
P(T<=t) one-tail		0.30	
t Critical one-tail		1.69	
P(T<=t) two-tail		0.61	
t Critical two-tail		2.03	

Difference in Q8 means by Q1 is NOT statistically significant.

Technical: Fail to reject the null hypothesis for Q8 by Q1

## Summary

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In a one-tailed test, T-TEST always tests whether the positive difference between the larger sample statistic and the smaller is statistically-significant.

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“Reject the null hypothesis” and “Failure to reject the null hypothesis” are technical conclusions.

“A difference IS [or IS NOT] statistically significant” is a less-technical conclusion.

Use the less-technical expressions for everyday communication.