

Producing graphs in Excel 2010:

To produce a simple bar chart:

1. **Enter the data.** Here, I'm going to produce a graph that contains a set of bars. It will show mean annual expenditure on beer, pizza, kebabs and shoes for men. That gives me four means to display. For each mean, I'm also going to show the associated standard deviation.

Here's how to lay out the data: just pick some empty cells anywhere in the spreadsheet.

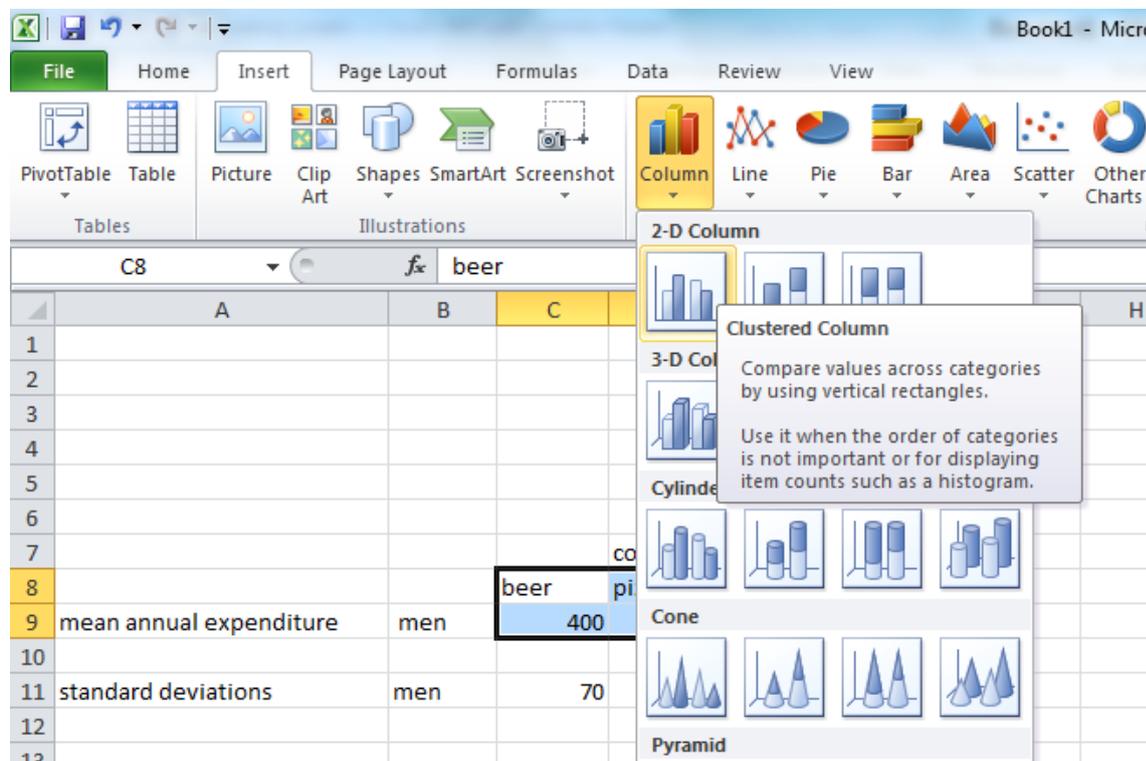
			commodity		
		beer	pizza	kebabs	shoes
mean annual expenditure	men	400	300	220	70
standard deviations	men	70	50	60	10

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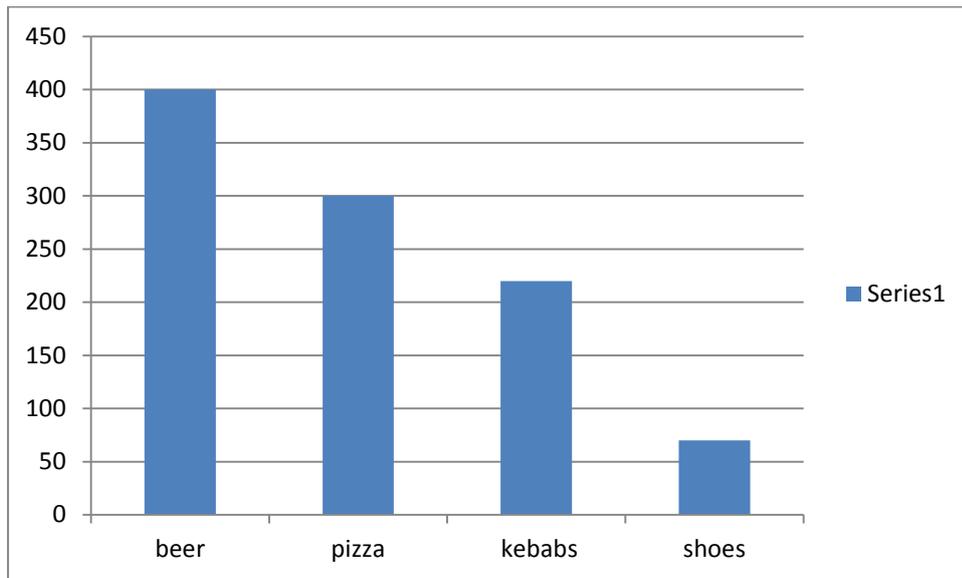
2. By clicking and dragging, **highlight** just the means and their labels (beer, pizza, etc).

			commodity		
		beer	pizza	kebabs	shoes
mean annual expenditure	men	400	300	220	70
standard deviations	men	70	50	60	10

3. Click on the tab labelled "**Insert**". In the area that deals with "**Charts**", select "**Column**". Click on the leftmost graph icon in the row that's headed "**2D column**".



This is the graph you should get:



To add the standard deviation to each mean:

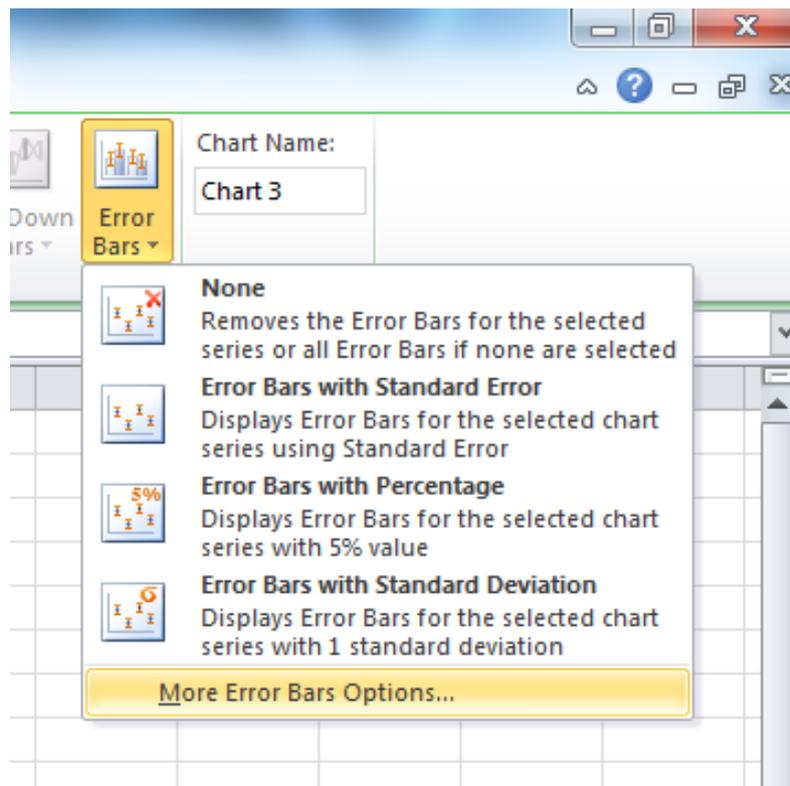
Click once on the chart to select the whole thing (make sure you don't click on the inner part of the chart because that will select just the axes and bars). The tabs at the top will change to show **"Chart tools"**. Select the **"Layout"** tab.

The screenshot shows the Excel interface with the 'Chart Tools' ribbon active. The 'Layout' tab is selected, showing options for Chart Area, Axes, Gridlines, Plot Area, Chart Wall, Chart Floor, 3-D, Trendline, Lines, Up/Down Bars, and Error Bars. The spreadsheet data is as follows:

		commodity			
		beer	pizza	kebabs	shoes
mean annual expenditure	men	400	300	220	70
standard deviations	men	70	50	60	10

The bar chart overlaid on the spreadsheet shows the mean annual expenditure for each commodity: beer (400), pizza (300), kebabs (220), and shoes (70). The y-axis ranges from 0 to 450.

Click on **"Error Bars"**, and then click on **"More Error Bars Options..."** at the bottom.



A new dialog box appears, called "**Format Error Bars**". Most of the time, the default values in this dialog box are fine. We want a vertical error bar on each bar of the graph, to show the mean plus and minus one standard deviation. So we want the "direction" of the error bars to be "both", and the "End Style" to be "Cap", as they are by default. **However, when it comes to specifying the length of the bars, under the heading "Error Amount", IGNORE the "Standard deviation" and "Standard Error" options - these will NOT produce the correct error bars! Follow this procedure instead.**

(a) Click on "custom", then click on "Specify Value". A dialog box labelled "Custom Error Bars" will appear.

The screenshot shows an Excel spreadsheet with a bar chart. The chart displays the mean annual expenditure for men on four commodities: beer (400), pizza (300), kebabs (220), and shoes (70). The y-axis represents the expenditure amount, ranging from 0 to 450. The bar for beer has a vertical error bar extending from 0 to 400. The 'Format Error Bars' dialog box is open, showing the 'Vertical Error Bars' tab. The 'Direction' is set to 'Both', and the 'End Style' is set to 'Cap'. The 'Error Amount' is set to 'Custom', and the 'Specify Value' button is highlighted. The 'Custom Error Bars' sub-dialog is also open, showing the 'Positive Error Value' set to 400 and the 'Negative Error Value' set to =(-1).

		commodity				
		beer	pizza	kebabs	shoes	
9	mean annual expenditure	men	400	300	220	70
11	standard deviations	men	70	50	60	10

(b) Click on the box underneath "**Positive Error Value**", to select it. (You may need to drag the "**Format Error Bars**" dialog box out of the way of your data before doing this). Click and drag on the cells that contain the standard deviations for the men. Then click on the box underneath "**Negative Error Value**" to select it, *and then click and drag on the same range of cells that you just entered into the "Positive Error Value" box.*

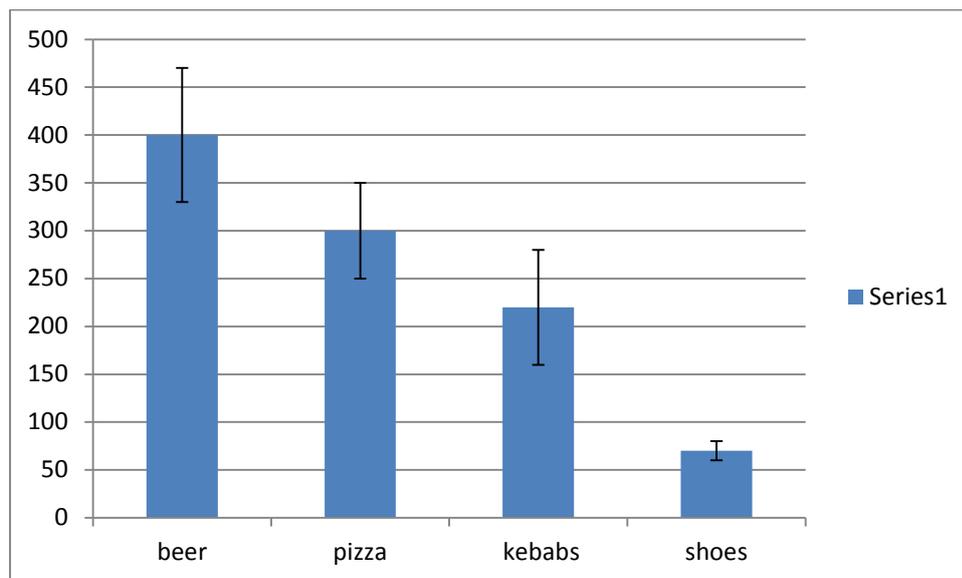
The screenshot shows an Excel spreadsheet with a bar chart. The chart has a vertical axis from 0 to 450 and a horizontal axis labeled 'beer'. A single blue bar is shown with error bars extending above and below the mean. The spreadsheet data is as follows:

		commodity				
		beer	pizza	kebabs	shoes	
9	mean annual expenditure	men	400	300	220	70
11	standard deviations	men	70	50	60	10

The 'Format Error Bars' dialog box is open, showing the 'Vertical Error Bars' tab. The 'Custom Error Bars' sub-dialog is also open, showing the 'Error Value' field set to '=Sheet1!\$C\$11:\$F\$11'. The 'Error Amount' section has 'Standard deviation(s)' selected with a value of 1.0.

Essentially you are telling Excel exactly how to draw the error bars. You want each one to be a particular mean plus and minus its associated standard deviation. Excel remembers the range of cells that contain the means for the men, so by entering the range of cells that contain the men's standard deviation values into the "Positive error value" and "Negative error value" boxes, you are supplying Excel with the values that it will need to add and subtract from each mean in order to produce the correct error bars.

This is what the graph will now look like:



Note that each error bar is different - that's because the standard deviation for each bar is different. (If you try to use the "standard deviation" or "standard error" options in the "Format Error Bars" dialog box, you will end up with the same size error bar on every bar in a series, which is *not* what is wanted!)

If you want to include standard errors instead of standard deviations, use exactly the same procedure but replace the spreadsheet cells containing the standard deviations with cells containing standard errors.

Here are my standard deviations, as used above:

standard deviations	men	70	50	60	10
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Let's suppose that I had ten men in this study. The standard error consists of the standard deviation divided by the square root of the number of participants.

In Excel, the formula for working out a standard error from a standard deviation is:

$$=xx/SQRT(10)$$

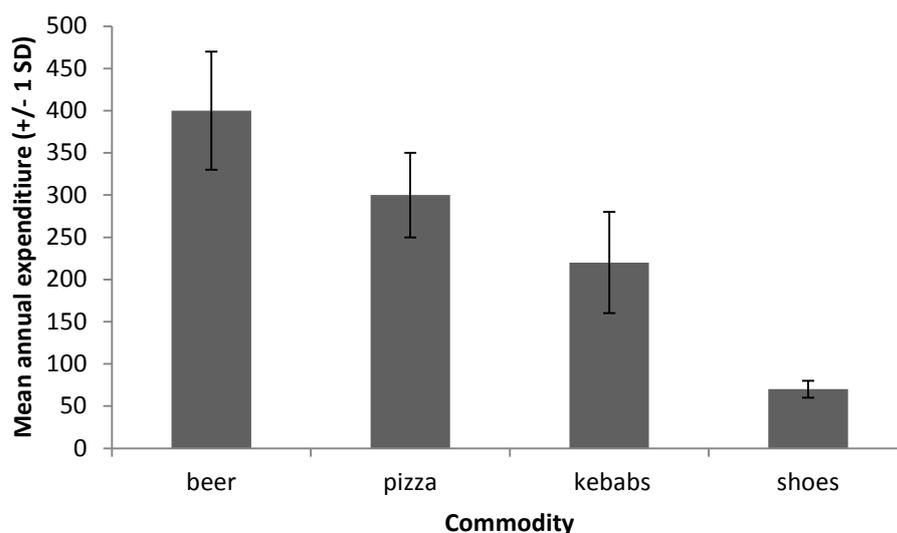
where xx is the location of the cell containing the standard deviation.

In my particular spreadsheet, cell C11 contains the standard deviation for the men's mean expenditure on beer. So somewhere else in the spreadsheet, I click on an empty cell and type "=C11/SQRT(10)", and Excel will enter 22.13594 into that cell (the value of the standard error).

Standard errors	men	22.13594	15.8113883	18.97367	3.162278
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Don't forget to make your graph conform to APA format. Click on the graph, and these options will appear on the "Layout" tab. Some options can also be accessed by right-clicking on the graph itself.

This is what the finished graph should look like:



To produce a more complicated bar chart:

1. **Enter the data.** Here, I'm going to produce a graph that contains two sets of bars. One set will show mean annual expenditure on beer, pizza, kebabs and shoes for men. The other set will show the same data for women. That gives me eight means to display. For each mean, I'm also going to show the associated standard deviation. Here's how to lay out the data: just pick some empty cells anywhere in the spreadsheet.

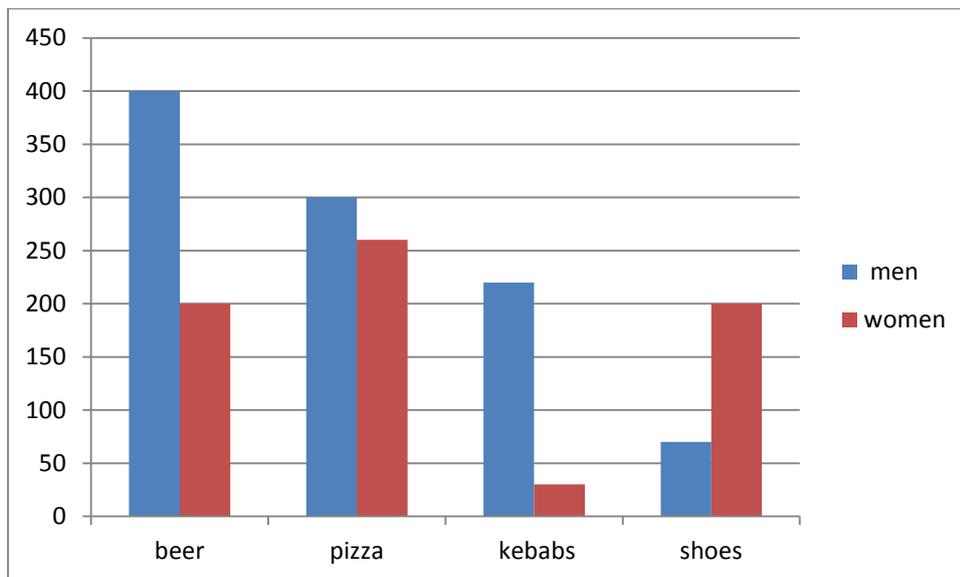
		beer	pizza	kebabs	shoes
mean annual expenditure	men	400	300	220	70
	women	200	260	30	200
standard deviations	men	70	50	60	10
	women	100	60	30	50

2. By clicking and dragging, **highlight** just the means and their labels (men, women, beer, pizza, etc).

		beer	pizza	kebabs	shoes
mean annual expenditure	men	400	300	220	70
	women	200	260	30	200
standard deviations	men	70	50	60	10
	women	100	60	30	50

3. Click on the tab labelled "**Insert**". In the area that deals with "**Charts**", select "**Column**". Click on the leftmost graph icon in the row that's headed "**2D column**".

This is the graph you should get:

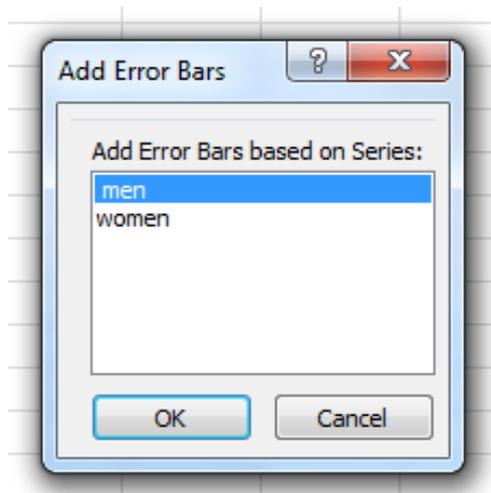


To add the standard deviation to each mean:

Click once on the chart to select the whole thing (make sure you don't click on the inner part of the chart because that will select just the axes and bars). The tabs at the top will change to show "**Chart tools**". Select the "**Layout**" tab.

Click on "**Error Bars**", and then click on "**More Error Bars Options...**" at the bottom.

The following dialog box pops up:



We have two "series" of data here, one series of means for men and one series for women. Click on "OK" to select the "men" series to begin with.

Follow the same procedure as before:

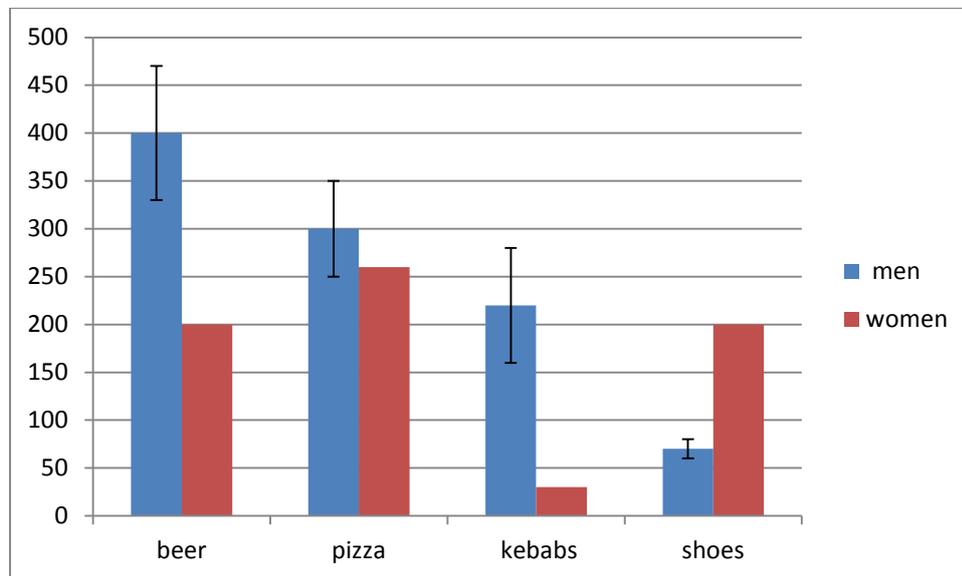
a) Click on "**custom**", then click on "**Specify Value**". A dialog box labelled "**Custom Error Bars**" will appear.

(b) Click on the box underneath "**Positive Error Value**", to select it.

Click and drag on the cells that contain the standard deviations for the men.

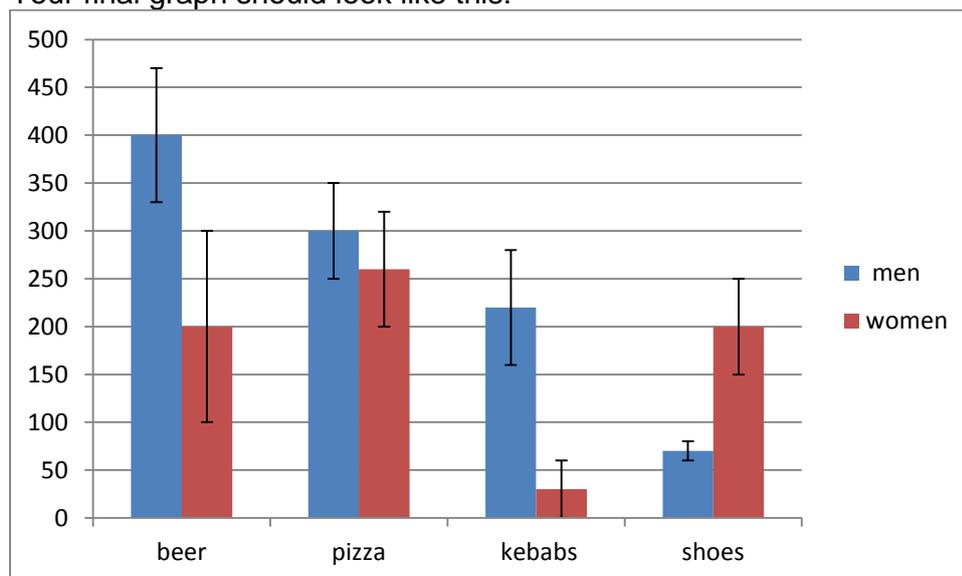
Then click on the box underneath "**Negative Error Value**" to select it, *and then click and drag on the same range of cells that you just entered into the "Positive Error Value" box.*

This is what the graph will now look like:



Having finished with the men's data, simply repeat the whole process to add the women's error bars. Go back to the "Error Bars" icon on the far right of the top strip, and repeat the whole process but using the cells containing the women's data instead.

Your final graph should look like this:



Let's suppose that I had ten men and ten women in this study. Have a go at working out the standard error for women using the same formula as before. You should get these values:

Standard errors	men	22.13594	15.81139	18.97367	3.162278
	women	31.62278	18.97367	9.486833	15.81139

Have a go at making a figure that conforms to APA format, with error bars containing the standard error. Your graph should end up looking like this:

