Example name	Viagra Levitra Cialis
Effect size	Risk ratio
Analysis type	Basic | Subgroups analysis
Level	Intermediate

Synopsis

The analysis includes 42 studies. All studies used the same paradigm, where patients suffering from erectile dysfunction were randomly assigned to either drug or placebo. Outcome was self-reports of improved function. The effect size was the risk ratio.

The active drug in some studies was Viagra, in some studies was Levitra, and in some studies was Cialis. We used subgroup analysis to see if the effect size varied by drug.

The original review includes various patient populations. For this example we use only studies based on the general population (excluding post-surgery patients, for example).

We use this example to show

- How to enter data from 2x2 tables
- How to get a sense of the weight assigned to each study
- How to interpret statistics for effect size
- How to interpret statistics for heterogeneity
- How to compute a prediction interval
- How to interpret a confidence interval and a prediction interval
- How to compare subgroup using a subgroups analysis
- How to compare subgroup using meta-regression

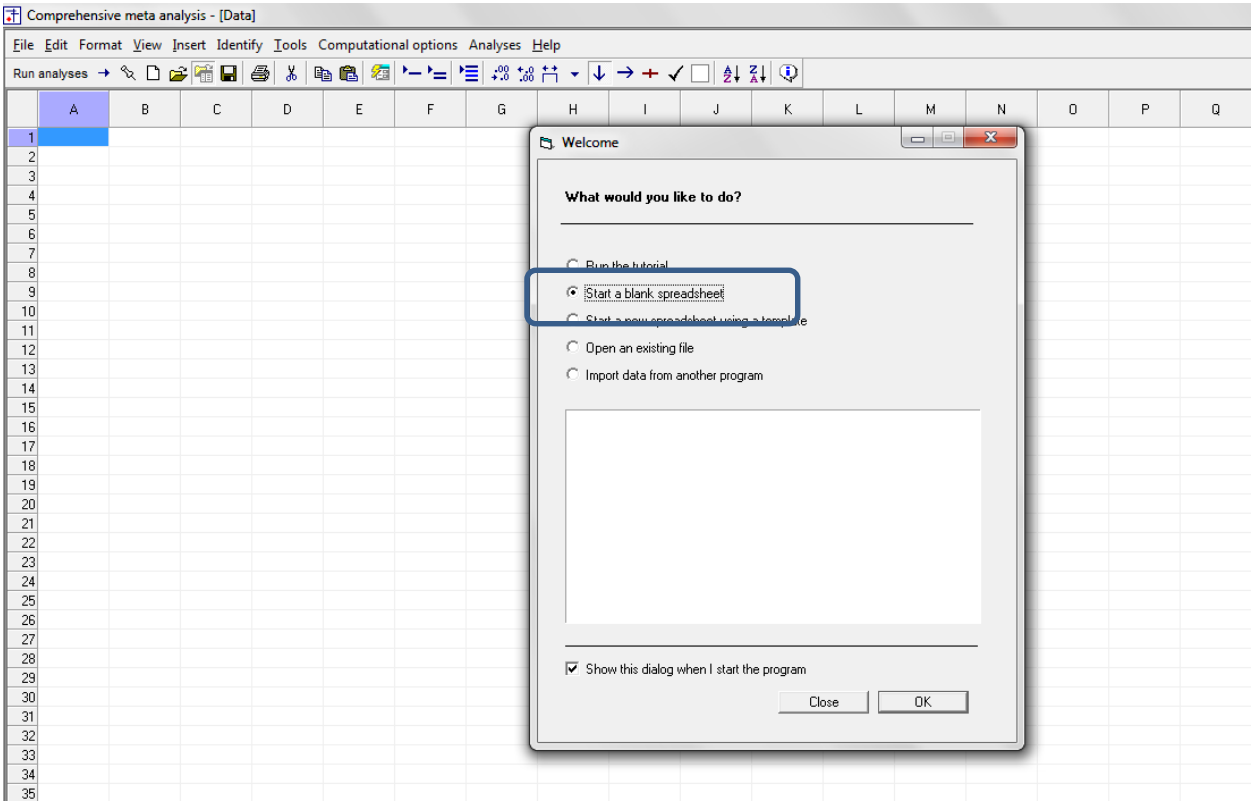
To open a CMA file > Download and Save file | Start CMA | Open file from within CMA

Download CMA file for computers that use a period to indicate decimals
Download CMA file for computers that use a comma to indicate decimals

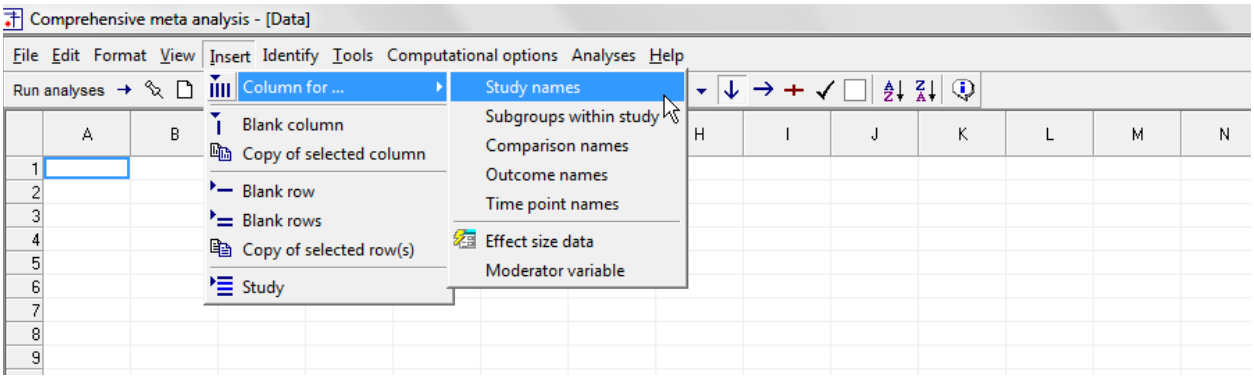
Download this PDF
Download data in Excel
Download trial of CMA

Start the program

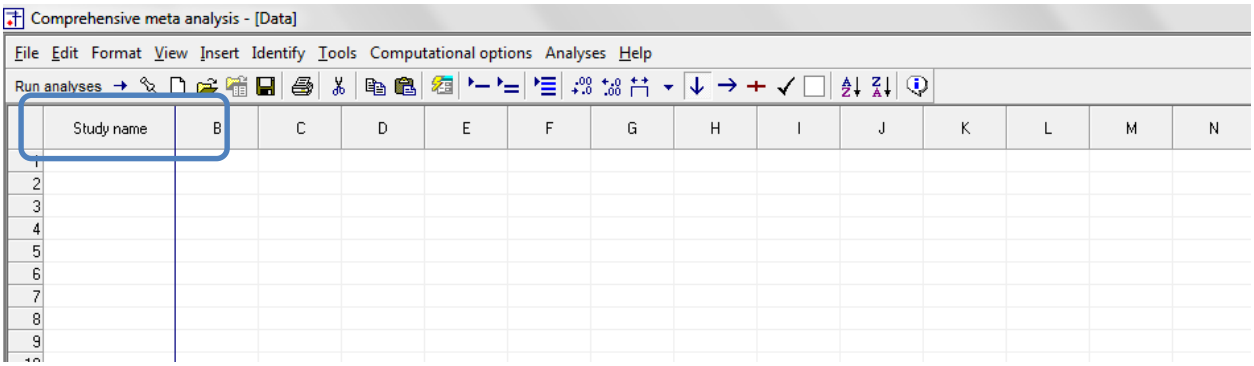
- Select the option [Start a blank spreadsheet]
- Click [Ok]



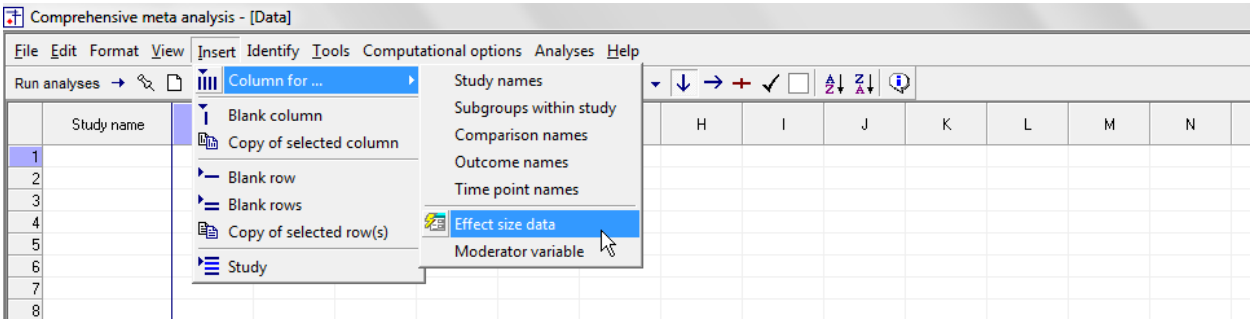
Click Insert > Column for > Study names



The screen should look like this

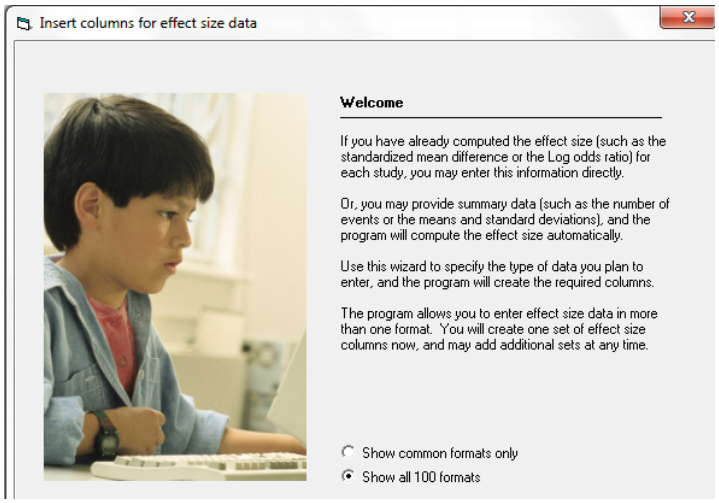


Click Insert > Column for > Effect size data

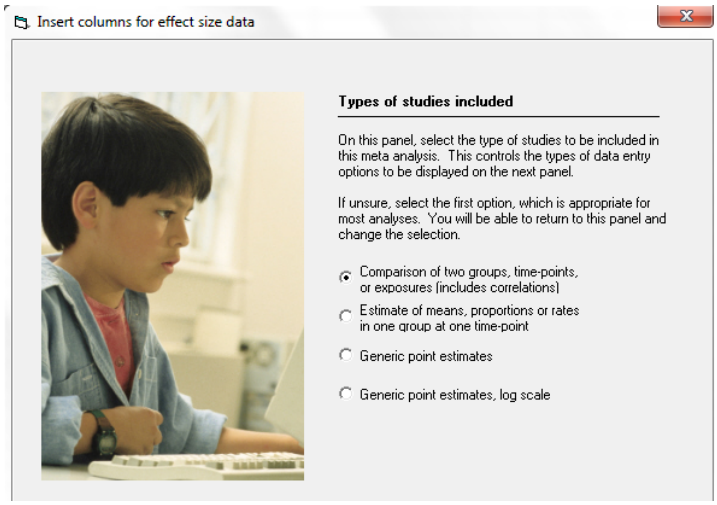


The program displays this wizard

Select [Show all 100 formats]
Click [Next]

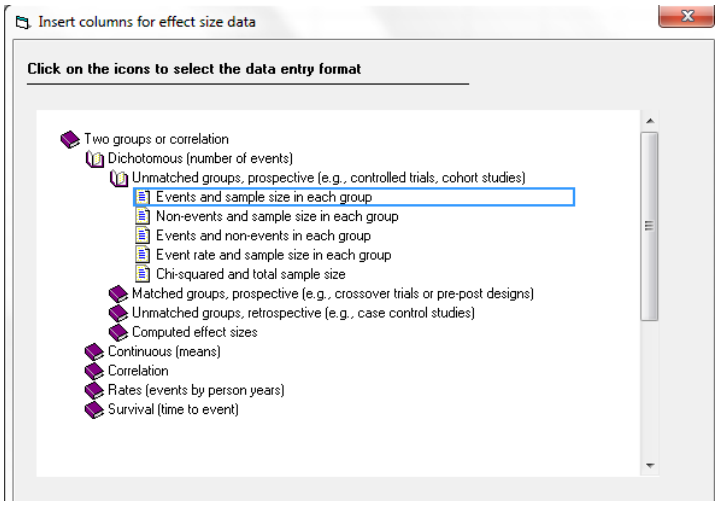


Select [Comparison of two groups…]
Click [Next]



Drill down to

Dichotomous (number of events)
Unmatched groups, prospective …
Events and sample size in each group

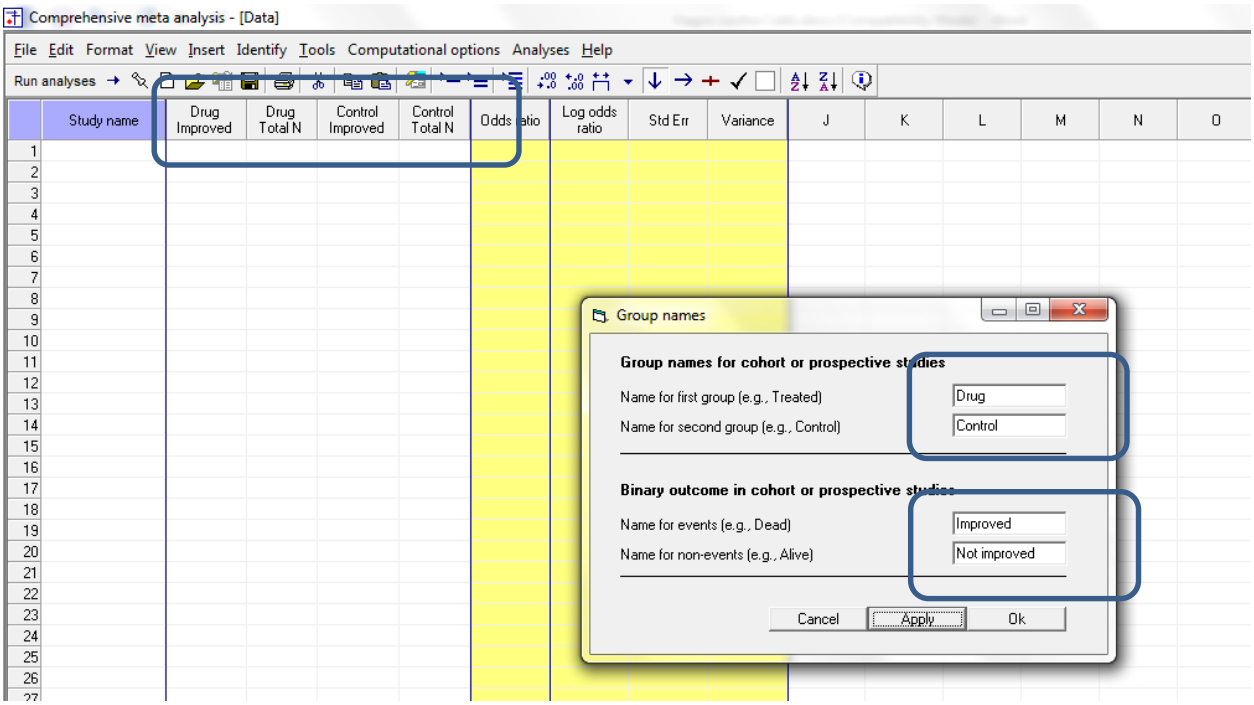


The program displays this wizard

Enter the following labels into the wizard

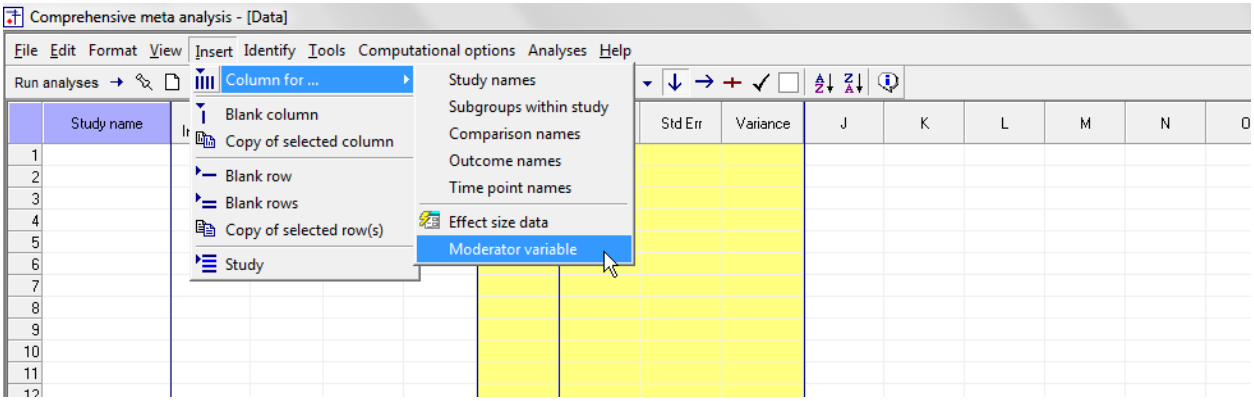
- First group > Drug
- Second group > Control
- Name for events > Improved
- Name for non-events > Not improved

Click [Ok] and the program will copy the names into the grid

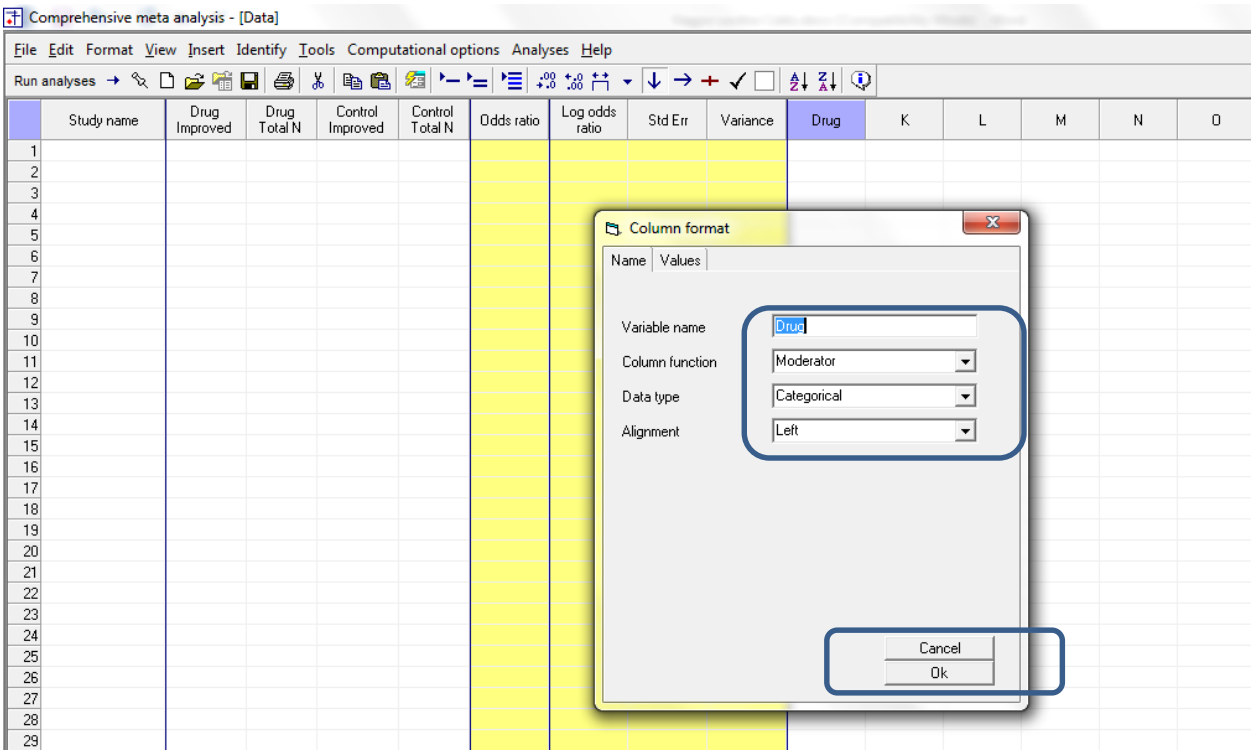


We need to add a column for the moderator, Drug

Click Insert > Column for > Moderator variable



- Name the moderator > Drug
- Set the data type to Categorical
- Click Ok

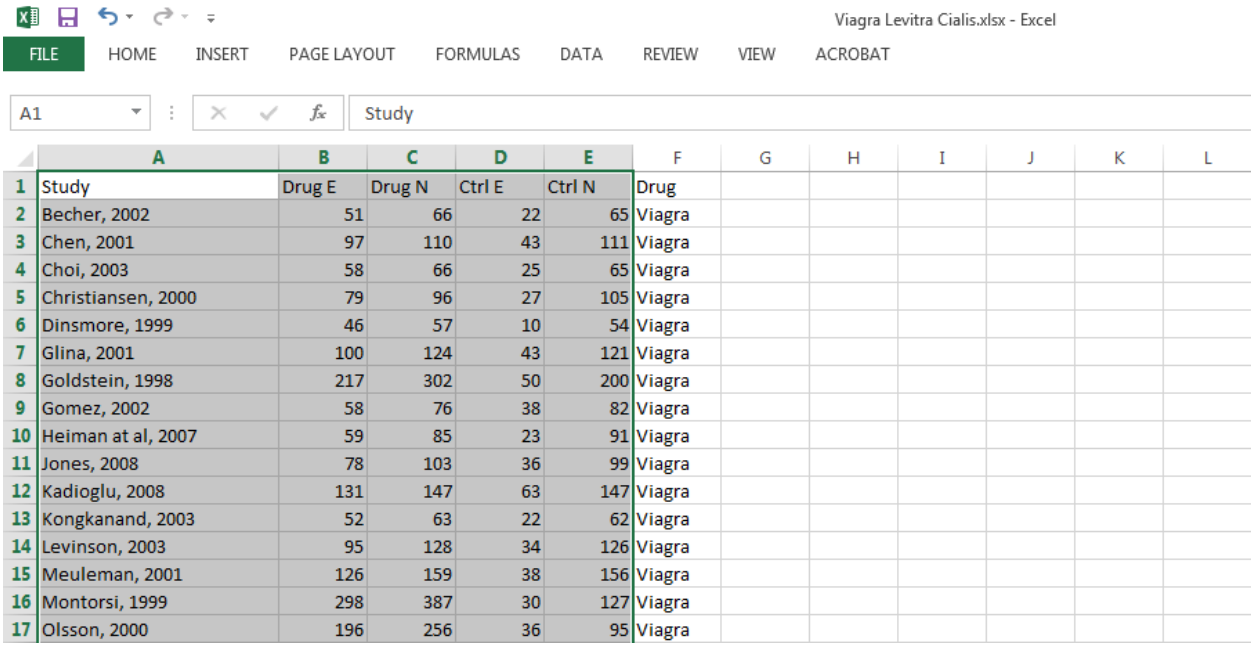


There are three options at this point

- Enter the data directly into CMA
- – or – Open the CMA data file
- – or – Copy the data from Excel

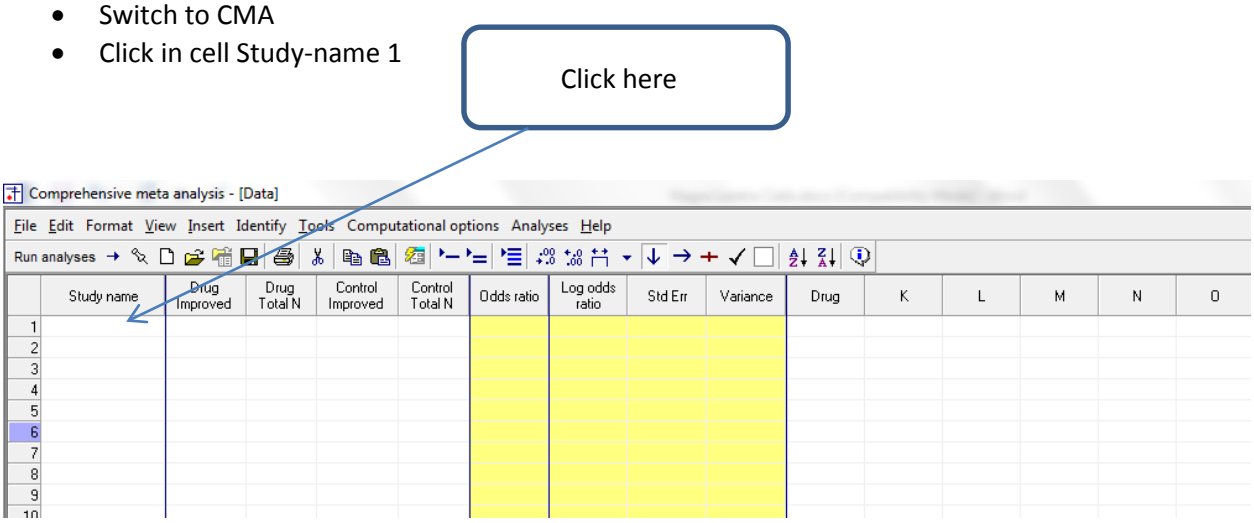
Here, we'll show how to copy the data from Excel

- Switch to Excel and open the file "Viagra Levitra Cialis.xls"
- Highlight the rows and columns as shown (Columns A to E only), and press CTRL-C to copy to clipboard

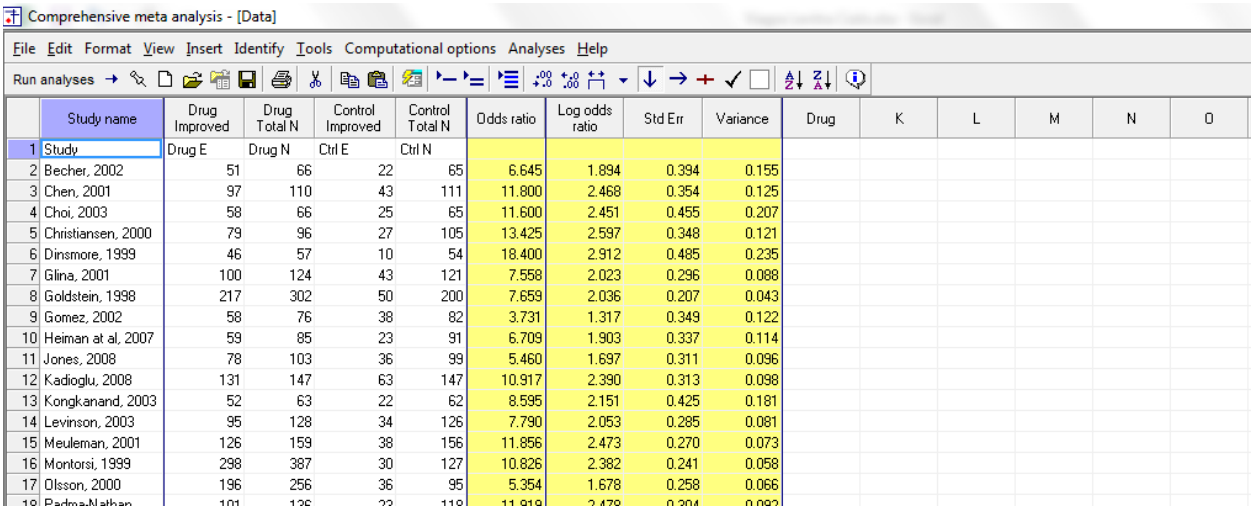


	A	B	C	D	E	F	G	H	I	J	K	L
1	Study	Drug E	Drug N	Ctrl E	Ctrl N	Drug						
2	Becher, 2002	51	66	22	65	Viagra						
3	Chen, 2001	97	110	43	111	Viagra						
4	Choi, 2003	58	66	25	65	Viagra						
5	Christiansen, 2000	79	96	27	105	Viagra						
6	Dinsmore, 1999	46	57	10	54	Viagra						
7	Glina, 2001	100	124	43	121	Viagra						
8	Goldstein, 1998	217	302	50	200	Viagra						
9	Gomez, 2002	58	76	38	82	Viagra						
10	Heiman at al, 2007	59	85	23	91	Viagra						
11	Jones, 2008	78	103	36	99	Viagra						
12	Kadioglu, 2008	131	147	63	147	Viagra						
13	Kongkanand, 2003	52	63	22	62	Viagra						
14	Levinson, 2003	95	128	34	126	Viagra						
15	Meuleman, 2001	126	159	38	156	Viagra						
16	Montorsi, 1999	298	387	30	127	Viagra						
17	Olsson, 2000	196	256	36	95	Viagra						

- Switch to CMA
- Click in cell Study-name 1

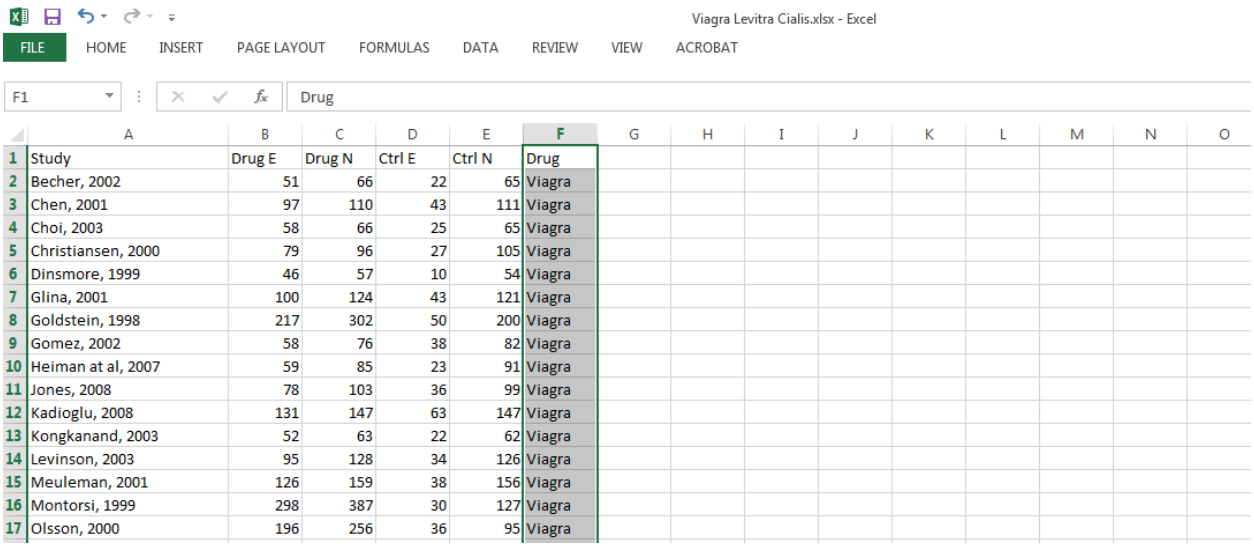


- Press [CTRL-V] to paste the data
- The screen should look like this (only first rows are shown)



	Study name	Drug Improved	Drug Total N	Control Improved	Control Total N	Odds ratio	Log odds ratio	Std Err	Variance
1	Study	Drug E	Drug N	Ctrl E	Ctrl N				
2	Becher, 2002	51	66	22	65	6.645	1.894	0.394	0.155
3	Chen, 2001	97	110	43	111	11.800	2.468	0.354	0.125
4	Choi, 2003	58	66	25	65	11.600	2.451	0.455	0.207
5	Christiansen, 2000	79	96	27	105	13.425	2.597	0.348	0.121
6	Dinsmore, 1999	46	57	10	54	18.400	2.912	0.485	0.235
7	Glina, 2001	100	124	43	121	7.558	2.023	0.296	0.088
8	Goldstein, 1998	217	302	50	200	7.659	2.036	0.207	0.043
9	Gomez, 2002	58	76	38	82	3.731	1.317	0.349	0.122
10	Heiman at al, 2007	59	85	23	91	6.709	1.903	0.337	0.114
11	Jones, 2008	78	103	36	99	5.460	1.697	0.311	0.096
12	Kadioglu, 2008	131	147	63	147	10.917	2.390	0.313	0.098
13	Kongkanand, 2003	52	63	22	62	8.595	2.151	0.425	0.181
14	Levinson, 2003	95	128	34	126	7.790	2.053	0.285	0.081
15	Meuleman, 2001	126	159	38	156	11.856	2.473	0.270	0.073
16	Montorsi, 1999	298	387	30	127	10.826	2.382	0.241	0.058
17	Olsson, 2000	196	256	36	95	5.354	1.678	0.258	0.066

- Switch to Excel
- Highlight the column for Drug and click [CTRL-C]



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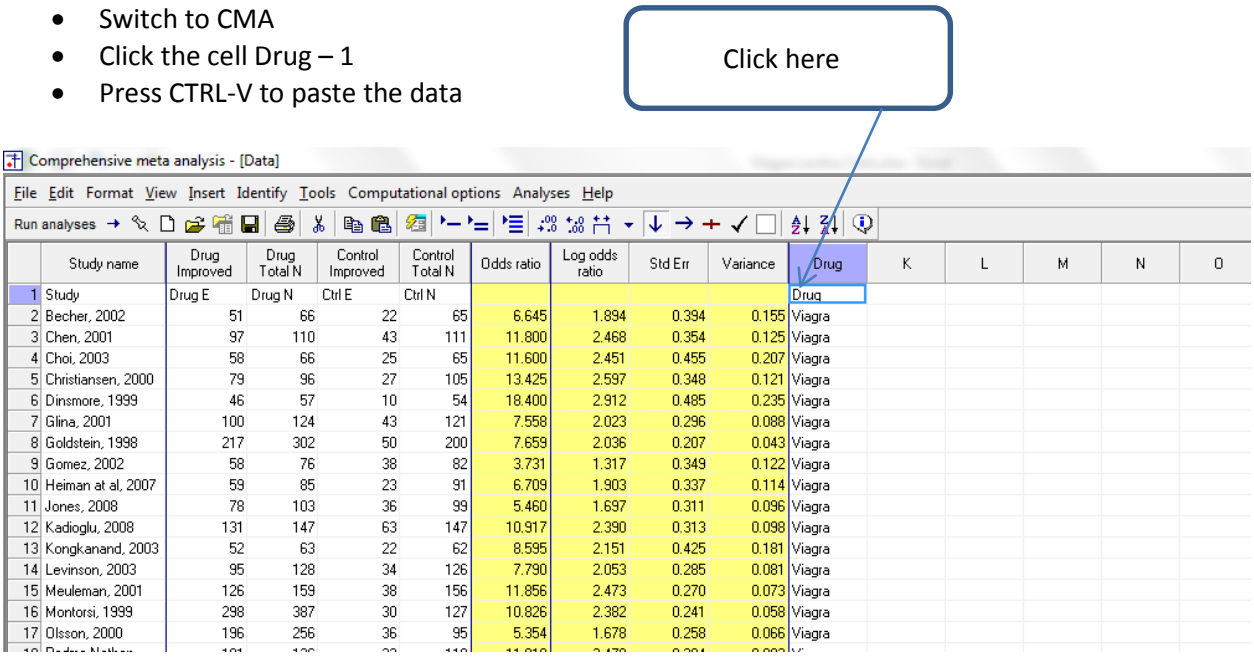
17	Olsson, 2000	196	256	36	95	Viagra

- Switch to CMA
- Click the cell Drug – 1
- Press CTRL-V to paste the data



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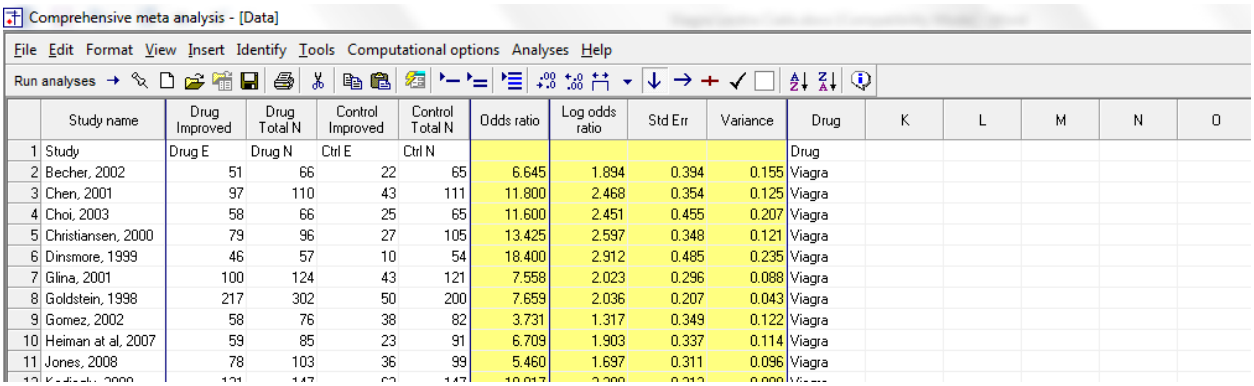
17	Olsson, 2000	196	256	36	95	5.354	1.678	0.258	0.066	Viagra

At this point we should check that the data has been copied correctly



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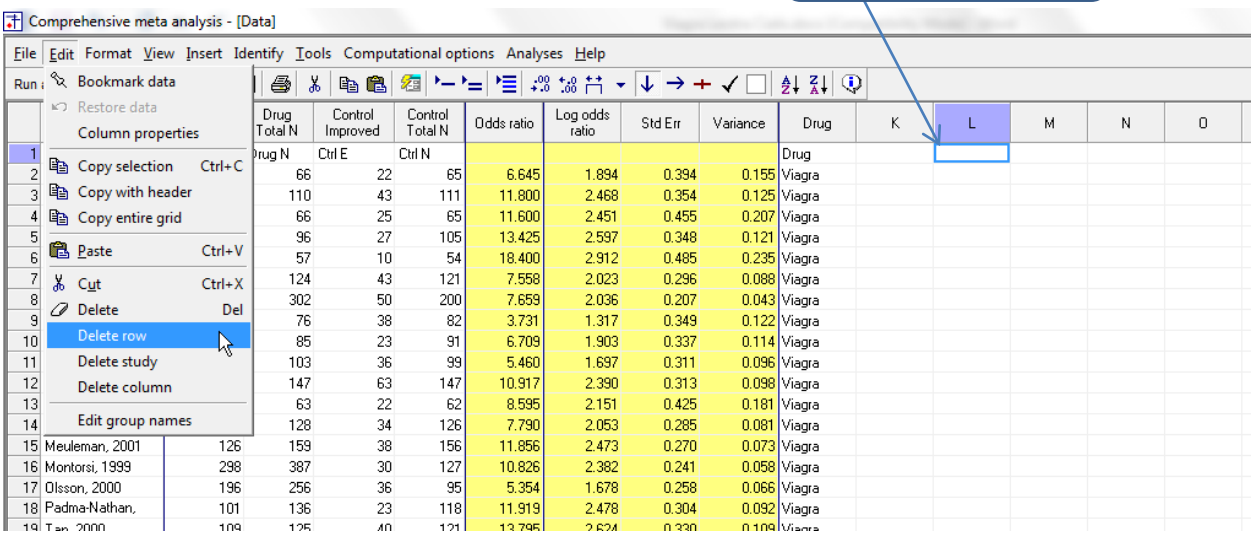
11	Jones, 2008	78	103	36	99	5.460	1.697	0.311	0.096	Viagra

- Click anywhere in Row 1
- Select Edit > Delete row, and confirm



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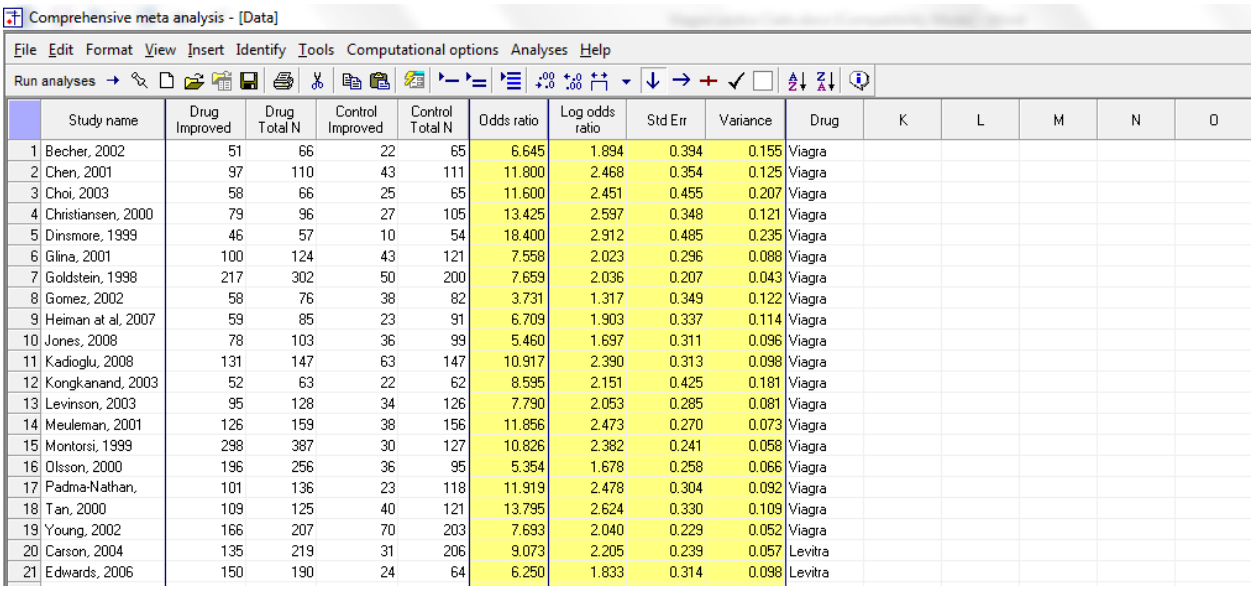
17	Olsson, 2000	196	256	36	95	5.354	1.678	0.258	0.066	Viagra
18	Padma-Nathan,	101	136	23	118	11.919	2.478	0.304	0.092	Viagra

The screen should look like this (top rows shown)



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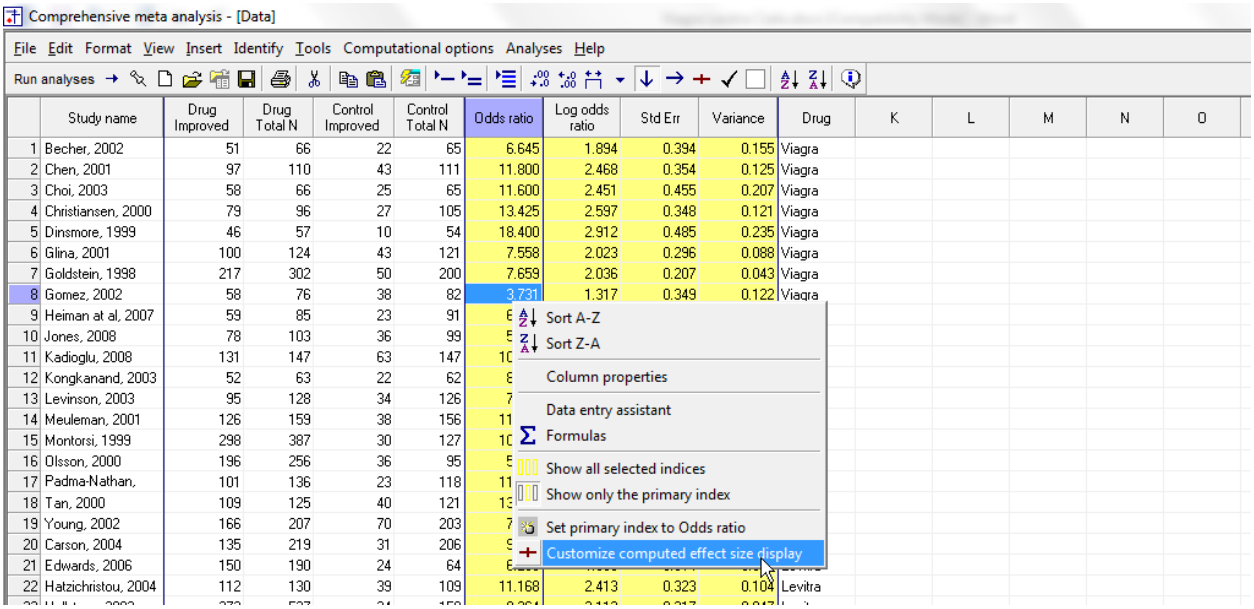
16	Olsson, 2000	196	256	36	95	5.354	1.678	0.258	0.066	Viagra
17	Padma-Nathan,	101	136	23	118	11.919	2.478	0.304	0.092	Viagra
18	Tan, 2000	109	125	40	121	13.795	2.624	0.330	0.109	Viagra
19	Young, 2002	166	207	70	203	7.693	2.040	0.229	0.052	Viagra
20	Carson, 2004	135	219	31	206	9.073	2.205	0.239	0.057	Levitra
21	Edwards, 2006	150	190	24	64	6.250	1.833	0.314	0.098	Levitra

By default, the program is displaying the odds ratio as the effect size

We want to switch to the risk ratio

- Right-click on any of the yellow columns
- Click Customize computed effect size display



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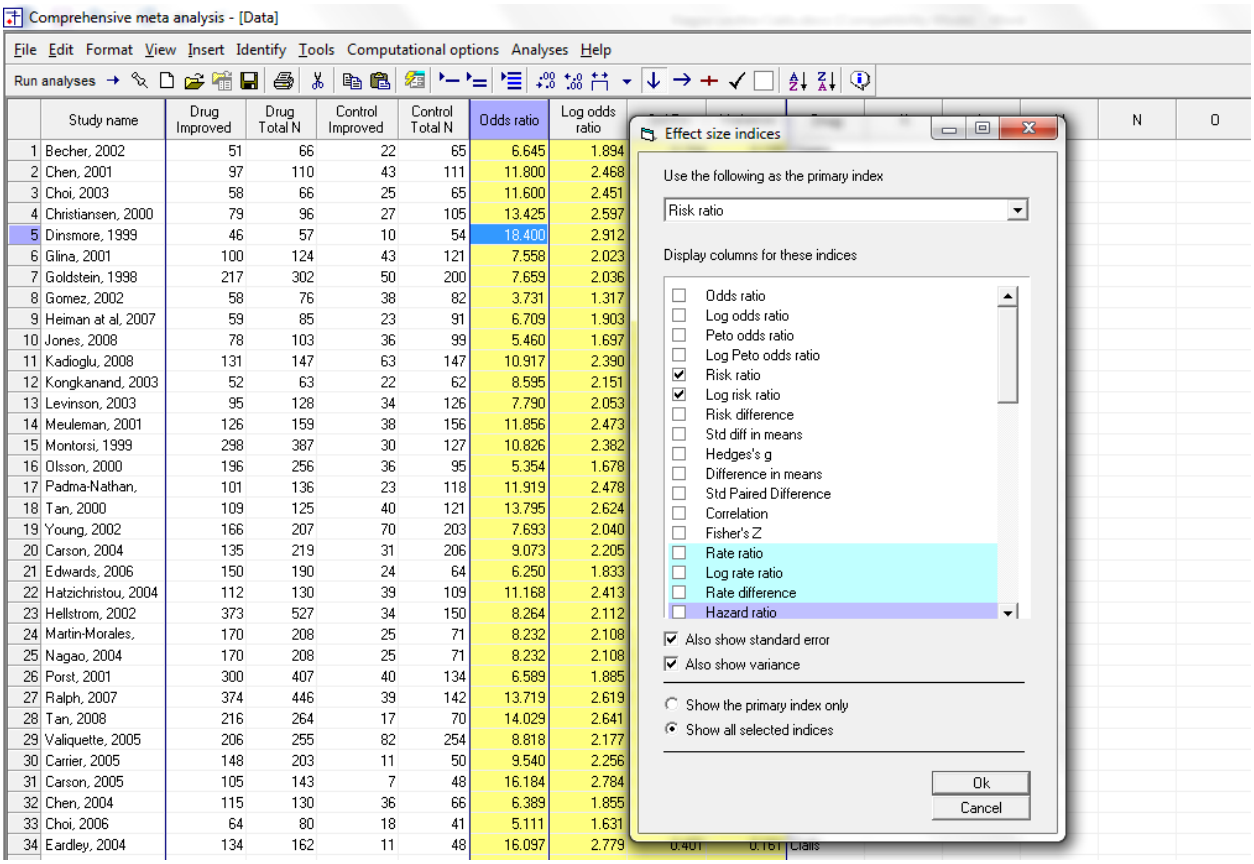
9	Heiman at al, 2007	59	85	23	91	6				
10	Jones, 2008	78	103	36	99	5				
11	Kadioglu, 2008	131	147	63	147	10				
12	Kongkanand, 2003	52	63	22	62	8				
13	Levinson, 2003	95	128	34	126	7				
14	Meuleman, 2001	126	159	38	156	11				
15	Montorsi, 1999	298	387	30	127	10				
16	Olsson, 2000	196	256	36	95	5				
17	Padma-Nathan,	101	136	23	118	11				
18	Tan, 2000	109	125	40	121	13				
19	Young, 2002	166	207	70	203	7				
20	Carson, 2004	135	219	31	206	9				
21	Edwards, 2006	150	190	24	64	6				
22	Hatzichristou, 2004	112	130	39	109	11.168	2.413	0.323	0.104	Levitra



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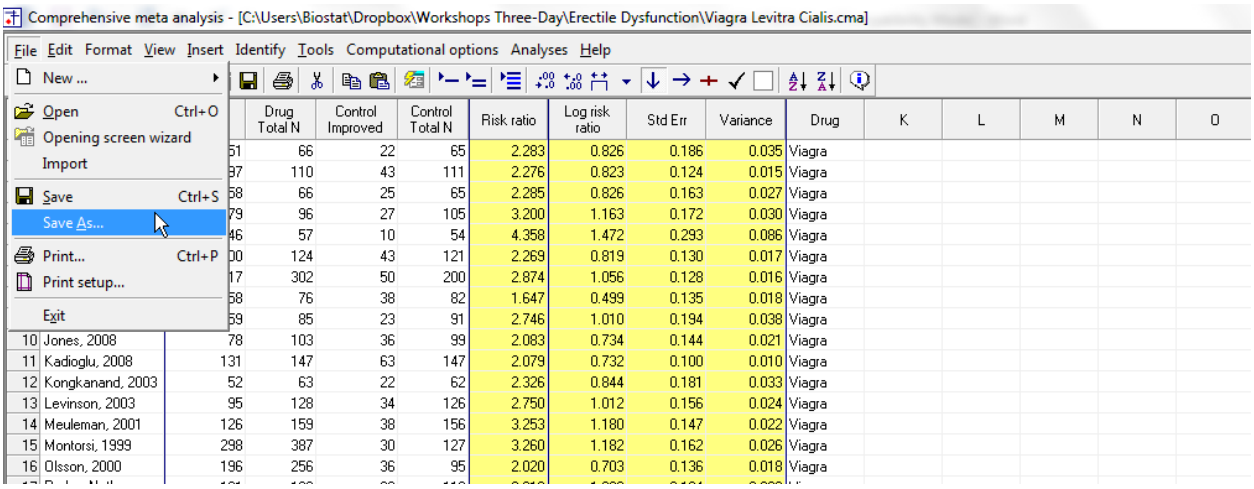
13	Levinson, 2003	95	128	34	126	7.790	2.053
14	Meuleman, 2001	126	159	38	156	11.856	2.473
15	Montorsi, 1999	298	387	30	127	10.826	2.382
16	Olsson, 2000	196	256	36	95	5.354	1.678
17	Padma-Nathan,	101	136	23	118	11.919	2.478
18	Tan, 2000	109	125	40	121	13.795	2.624
19	Young, 2002	166	207	70	203	7.693	2.040
20	Carson, 2004	135	219	31	206	9.073	2.205
21	Edwards, 2006	150	190	24	64	6.250	1.833
22	Hatzichristou, 2004	112	130	39	109	11.168	2.413
23	Hellstrom, 2002	373	527	34	150	8.264	2.112
24	Martin-Morales,	170	208	25	71	8.232	2.108
25	Nagao, 2004	170	208	25	71	8.232	2.108
26	Porst, 2001	300	407	40	134	6.589	1.885
27	Ralph, 2007	374	446	39	142	13.719	2.619
28	Tan, 2008	216	264	17	70	14.029	2.641
29	Valiquette, 2005	206	255	82	254	8.818	2.177
30	Carrier, 2005	148	203	11	50	9.540	2.256
31	Carson, 2005	105	143	7	48	16.184	2.784
32	Chen, 2004	115	130	36	66	6.389	1.855
33	Choi, 2006	64	80	18	41	5.111	1.631
34	Eardley, 2004	134	162	11	48	16.097	2.779

- Tick Risk ratio
- Tick Log risk ratio
- Select Risk ratio in the drop-down box in the wizard
- De-select Odds ratio
- De-select log odds ratio
- Click Ok

The program now display the risk ratio rather than the odds ratio

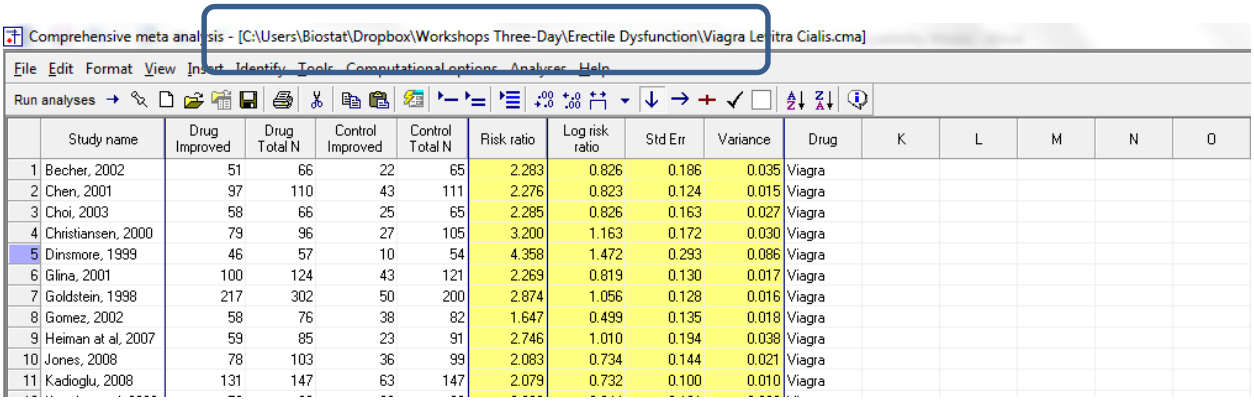
Click File > Save As and save the file



	Study name	Drug Improved	Drug Total N	Control Improved	Control Total N	Risk ratio	Log risk ratio	Std Err	Variance	Drug	K	L	M	N	O
1	Becher, 2002	51	66	22	65	2.283	0.826	0.186	0.035	Viagra					
2	Chen, 2001	97	110	43	111	2.276	0.823	0.124	0.015	Viagra					
3	Choi, 2003	58	66	25	65	2.285	0.826	0.163	0.027	Viagra					
4	Christiansen, 2000	79	96	27	105	3.200	1.163	0.172	0.030	Viagra					
5	Dinsmore, 1999	46	57	10	54	4.358	1.472	0.293	0.086	Viagra					
6	Glina, 2001	100	124	43	121	2.269	0.819	0.130	0.017	Viagra					
7	Goldstein, 1998	217	302	50	200	2.874	1.056	0.128	0.016	Viagra					
8	Gomez, 2002	58	76	38	82	1.647	0.499	0.135	0.018	Viagra					
9	Heiman at al, 2007	59	85	23	91	2.746	1.010	0.194	0.038	Viagra					
10	Jones, 2008	78	103	36	99	2.083	0.734	0.144	0.021	Viagra					
11	Kadioglu, 2008	131	147	63	147	2.079	0.732	0.100	0.010	Viagra					
12	Kongkanand, 2003	52	63	22	62	2.326	0.844	0.181	0.033	Viagra					
13	Levinson, 2003	95	128	34	126	2.750	1.012	0.156	0.024	Viagra					
14	Meuleman, 2001	126	159	38	156	3.253	1.180	0.147	0.022	Viagra					
15	Montorsi, 1999	298	387	30	127	3.260	1.182	0.162	0.026	Viagra					
16	Olsson, 2000	196	256	36	95	2.020	0.703	0.136	0.018	Viagra					

Note that the file name is now in the header.

- [Save] will over-write the prior version of this file without warning
- [Save As…] will allow you to save the file with a new name



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11	Kadioglu, 2008	131	147	63	147	2.079	0.732	0.100	0.010	Viagra					

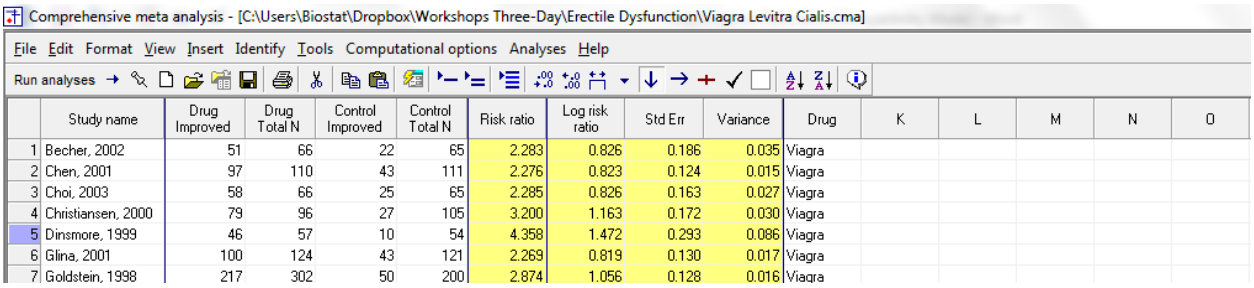
By convention we've put the treated group (Drug) in the first two columns and the control (placebo) in the second two columns. Also by convention, we've defined "Event" as the presence of the outcome (improvement).

When we follow these conventions, and if the treated group does better than the control, then

- If the "event" is a bad outcome (such as relapse), the risk ratio will be less than 1.
- If the "event" is a good outcome (such as improvement), the risk ratio will be greater than 1.

Therefore, in the present case, a risk ratio greater than 1 indicates that patients treated with drug were more likely to improve then those treated with placebo.

It's always a good idea to check at least one study and make sure that we have the direction right. For this purpose we'll use the first study (Becher), where the risk ratio is high, and the distinction between groups should be clear.



	Study name	Drug Improved	Drug Total N	Control Improved	Control Total N	Risk ratio	Log risk ratio	Std Err	Variance	Drug	K	L	M	N	O
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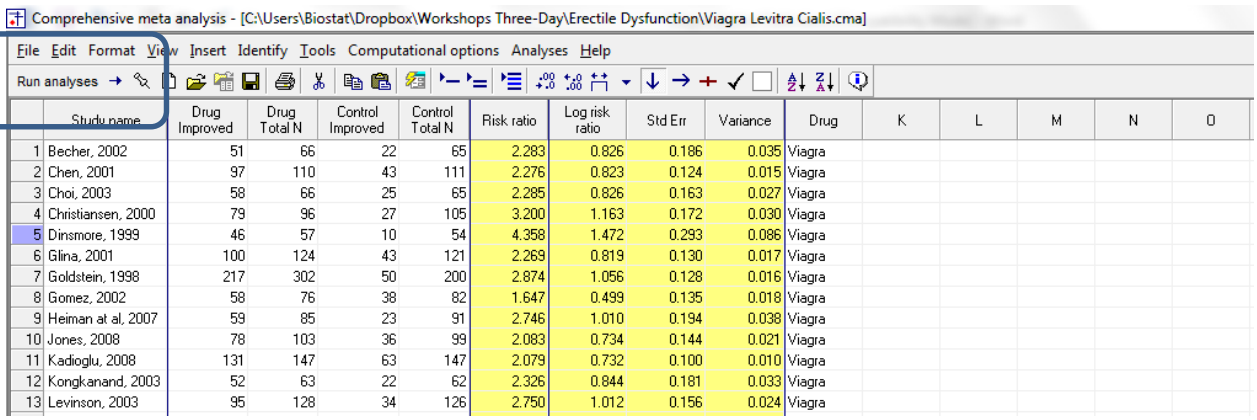
7	Goldstein, 1998	217	302	50	200	2.874	1.056	0.128	0.016	Viagra					

- For the drug group, nearly 80% of the patients (51/66) improved.
- For the control group, only about 33% (22/65) improved.

Clearly, the treated group did better, and the risk ratio (2.283) is greater than one. This tells us that we are interpreting the direction of the effect size properly.

To run the analysis, click [Run analysis]



	Study name	Drug Improved	Drug Total N	Control Improved	Control Total N	Risk ratio	Log risk ratio	Std Err	Variance	Drug	K	L	M	N	O
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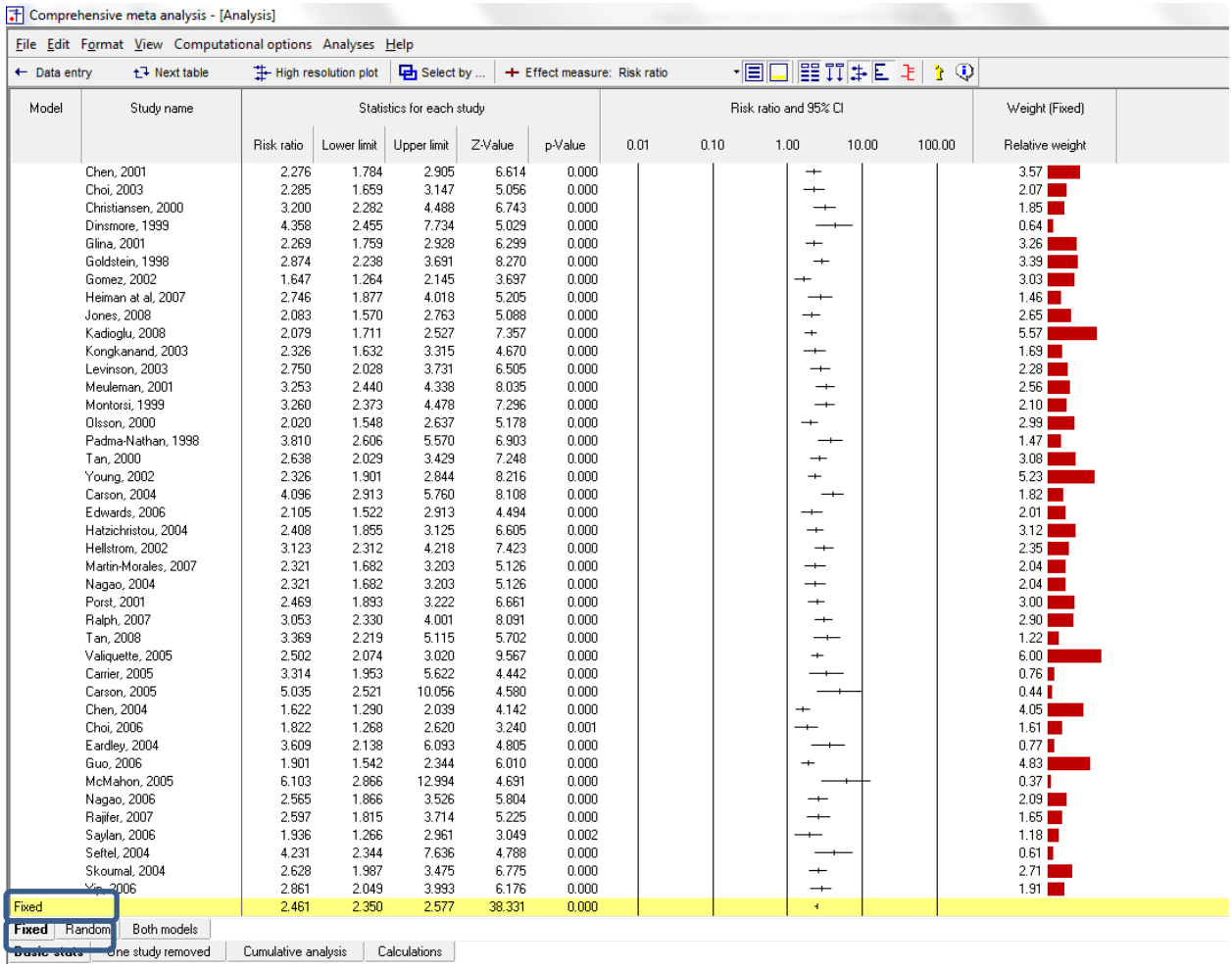
12	Kongkanand, 2003	52	63	22	62	2.326	0.844	0.181	0.033	Viagra					
13	Levinson, 2003	95	128	34	126	2.750	1.012	0.156	0.024	Viagra					

This is the basic analysis screen

Initially, the program displays the fixed-effect analysis. This is indicated by the tab at the bottom and the label in the plot.



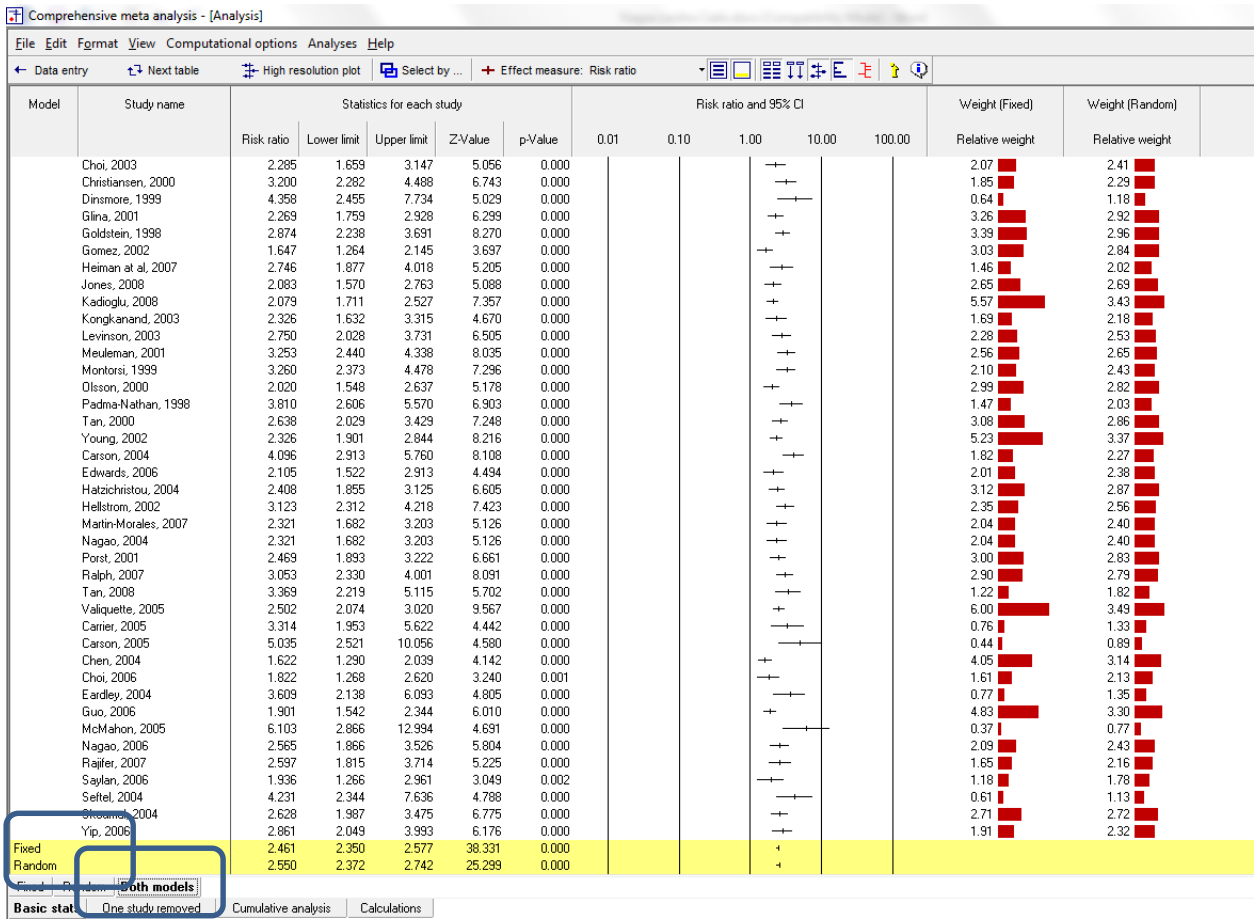
Every one of the studies has a risk ratio over 1.0, which means that the treated group did better than the control. In fact, the effect is statistically significant in every one of the studies.

The pooled effect is 2.461, which means that patients treated with the drug were almost 2.5 times more likely to report improvement as compared with those treated with placebo.

There is substantial variation in the observed effects. We'll need to see what proportion of this may be attributed to sampling error, and what proportion is real.

Click [Both models]

The program displays results for both the fixed-effect and the random-effects analysis.



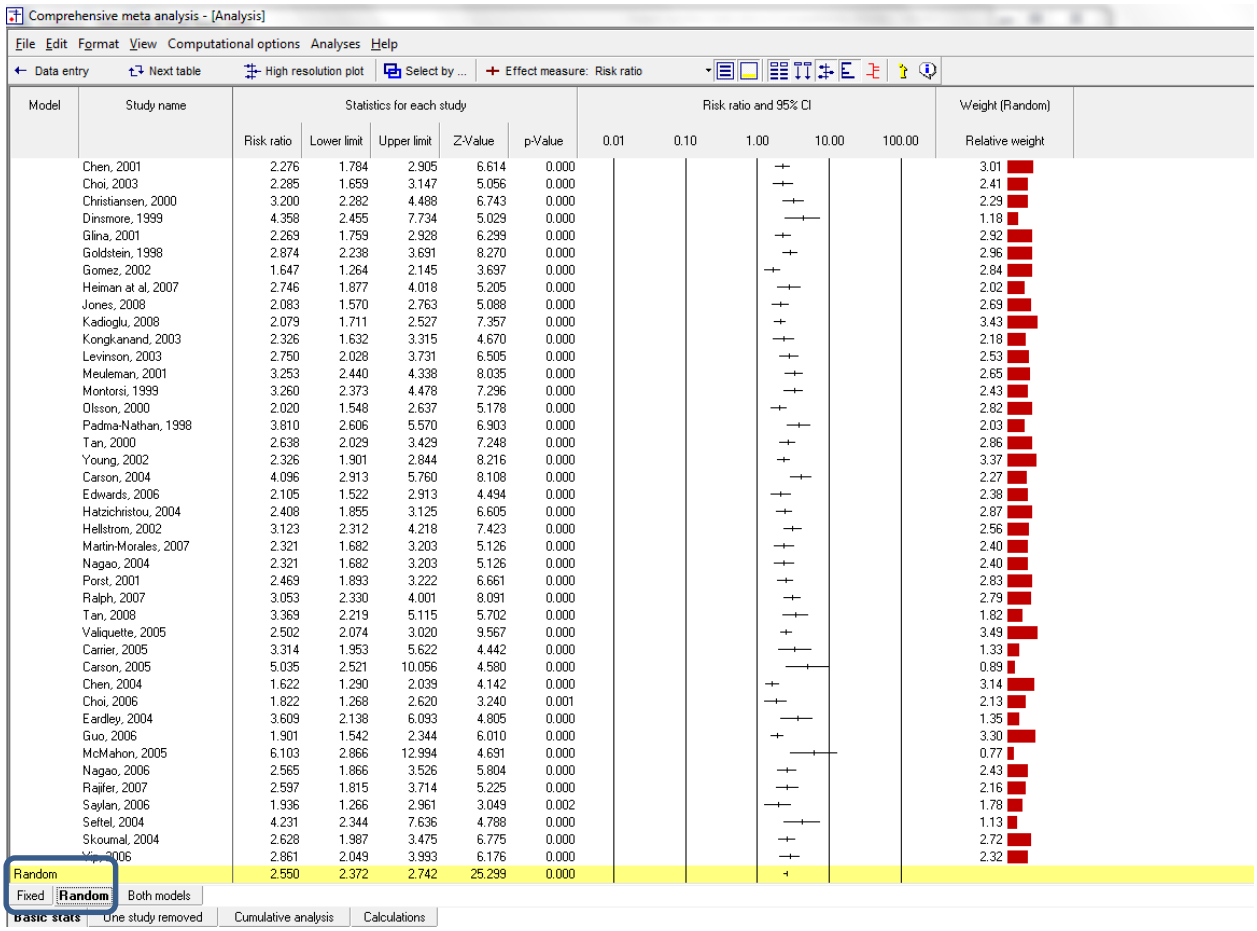
Under the fixed-effect model the pooled effect size is 2.461, while under the random-effects model the pooled effect size is 2.550. While the two models yield very similar results, the random-effects model is a better fit for the way the studies were sampled, and therefore that is the model we will use in the analysis.

- The fixed-effect model would be appropriate if all the studies were virtual replicates of each other, which is not the case here. The dose varied, the analgesic varied, the patients varied.

- The random-effects model would be appropriate if the studies vary in ways that may impact the effect size (such as those mentioned immediately above). Therefore, we will use the random-effects model.

- Click Random on the tab at the bottom

The plot now displays the random-effects analysis alone.



A quick view of the plot suggests the following

- Drug was better than placebo in every study.
- This effect is statistically significant in every study.
- The risk ratios vary from a low of 1.6 to a high of 6.1
- The summary effect is 2.550 with a CI of 2.372 to 2.742. Thus, we have a pretty precise estimate of the mean effect size.
- The summary effect has a Z-value 25.299 a *p*-value of < 0.001. Thus we can reject the null hypotheses that the true risk ratio is 1.0.

Click [Next table]

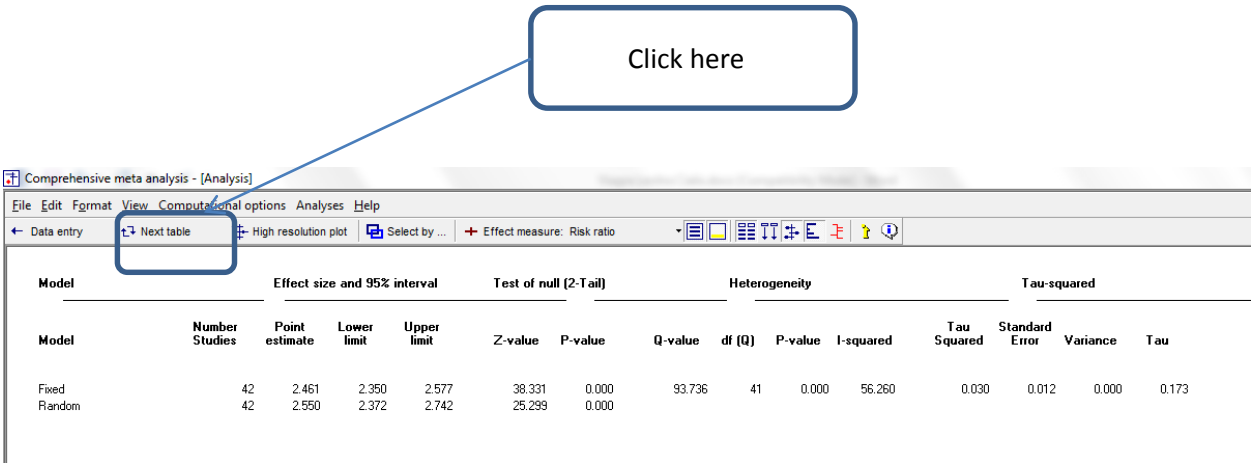


Figure 1

The statistics at the left duplicate those we saw on the prior screen.

- Under the random-effects model the risk ratio is 2.550 with a 95% confidence interval of 2.372 to 2.577. The test of the null (that the true risk ratio is 1.0) yields a Z-value of 25.299 and a corresponding p-value of < 0.001.
- The statistics at the upper right relate to the dispersion of effect sizes across studies.
- The Q-value is 93.736 with df=41 and p< 0.001. *Q* reflects the distance of each study from the mean effect (weighted, squared, and summed over all studies). Q is always computed using FE weights (which is the reason it is displayed on the "Fixed" row, but applies to both FE and RE analyses.
- If all studies actually shared the same true effect size, the expected value of Q would be equal to df (which is 41). Here, Q is greater than that value, and so there is some evidence of variance in true effects. This excess variance falls outside the range that could be attributed to random variation in effects (it is statistically significant).
- We had planned to use the random-effects model, since this matches the sampling frame for the studies, and would do so whether or not the Q-value was statistically significant.
- T^2 is the estimate of the between-study variance in true effects. This estimate is 0.030. *T* is the estimate of the between-study standard deviation in true effects. This estimate is 0.173. These value are both in log units.
- I^2 reflects the proportion of true variance to observed variance. This is 56.26, which tells us that about 56% of the observed variance in effects is real. Put another way, if we were looking at a plot of the true effects rather than the observed effects, the variance in effects would be decreased by (1 minus .56) some 44%.

We can use the spreadsheet [Prediction intervals] as follows

- Open the spreadsheet [Prediction Intervals.xls]
- Select the tab for [Ratios]
- In CMA select Log risk ratio as the index
- Copy the A|B|C|D values as shown from CMA to Excel

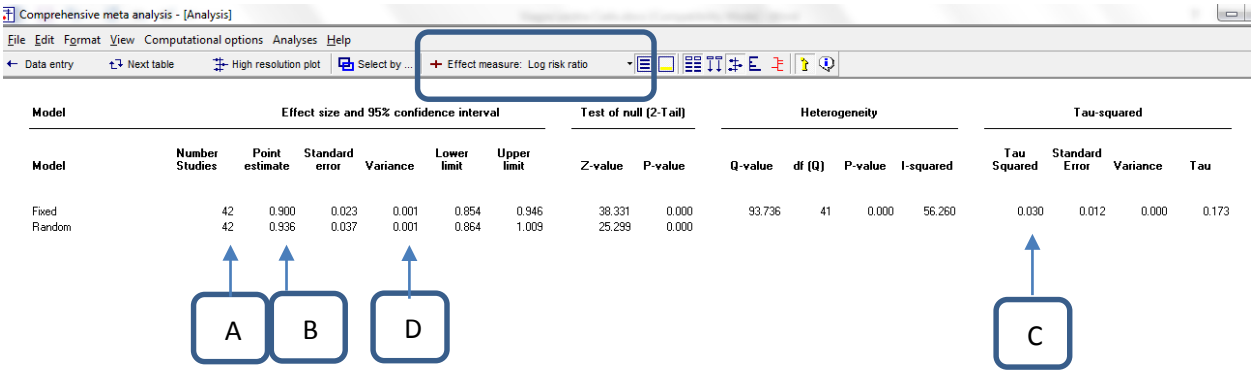
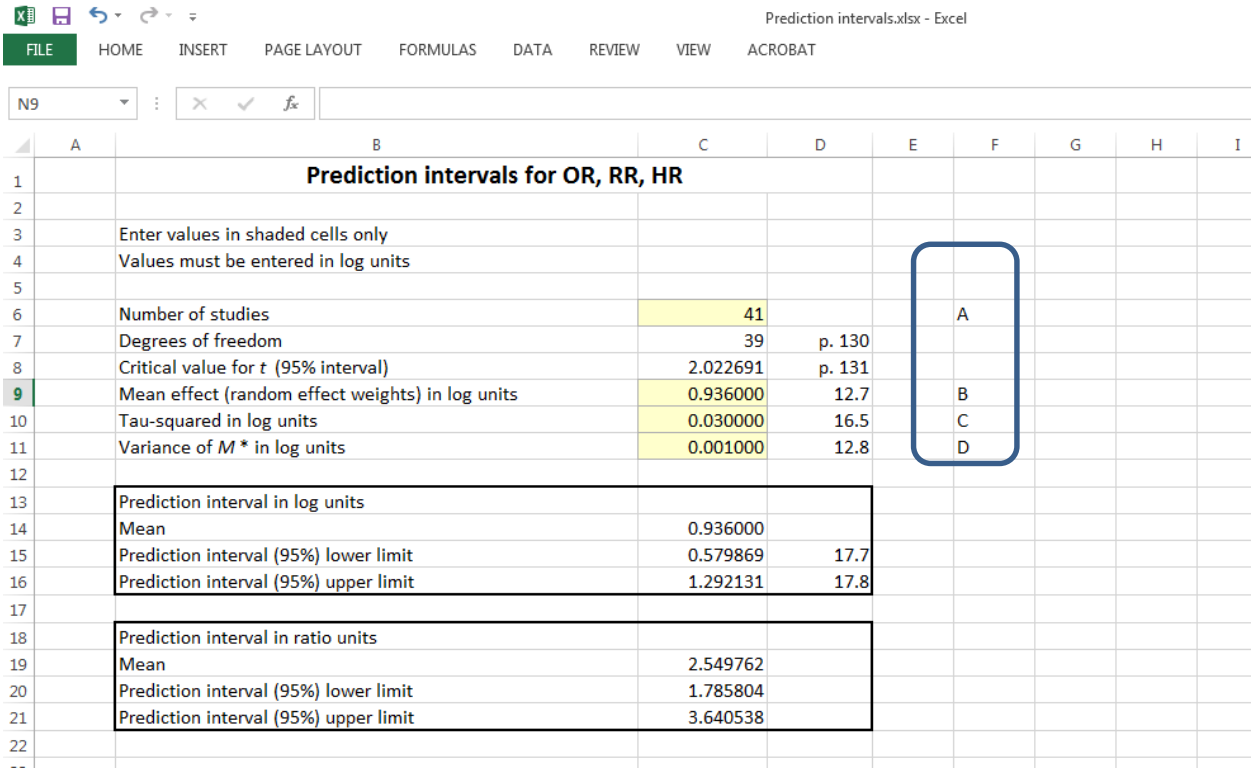


Figure 2



	A	B	C	D	E	F	G	H	I
1		**Prediction intervals for OR, RR, HR**							
2									
3		Enter values in shaded cells only							
4		Values must be entered in log units							
5									
6		Number of studies	41			A			
7		Degrees of freedom	39	p. 130					
8		Critical value for *t* (95% interval)	2.022691	p. 131					
9		Mean effect (random effect weights) in log units	0.936000	12.7		B			
10		Tau-squared in log units	0.030000	16.5		C			
11		Variance of *M* * in log units	0.001000	12.8		D			
12									
13		Prediction interval in log units							
14		Mean	0.936000						
15		Prediction interval (95%) lower limit	0.579869	17.7					
16		Prediction interval (95%) upper limit	1.292131	17.8					
17									
18		Prediction interval in ratio units							
19		Mean	2.549762						
20		Prediction interval (95%) lower limit	1.785804						
21		Prediction interval (95%) upper limit	3.640538						
22									

The confidence interval is 2.372 to 2.742 (we need to read this from Figure 1, where the index is the risk ratio, and not from Figure 2 where the index is the log risk ratio). The prediction interval (from Excel) is 1.785 to 3.641.

In 95% of all possible meta-analyses, the true mean will fall in the range indicated by the CI (2.372 to 2.742). In 95% of all meta-analyses, the true effect size for 95% of all studies will fall inside the range indicated by the PI (1.785 to 3.641). This assumes that the true effect sizes are normally distributed.

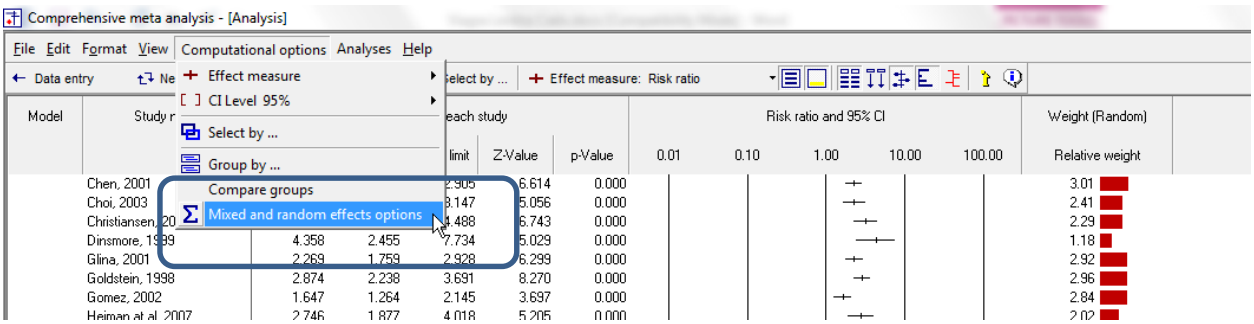
Click [Next table] to return to the main analysis screen.

To this point we've established that drug is effective, but that the magnitude of the effect varied from study to study. We know that some studies used Viagra, others used Levitra, and others used Cialis. We'd like to see if the effect was stronger in one subgroup of studies than another.

When we're dividing the studies into subgroups, the between-studies variance (T^2) must be computed within subgroups. However, we have two options. We can then pool the separate estimates, and use the pooled value for all subgroups. Or, we can use a separate estimate for each subgroup.

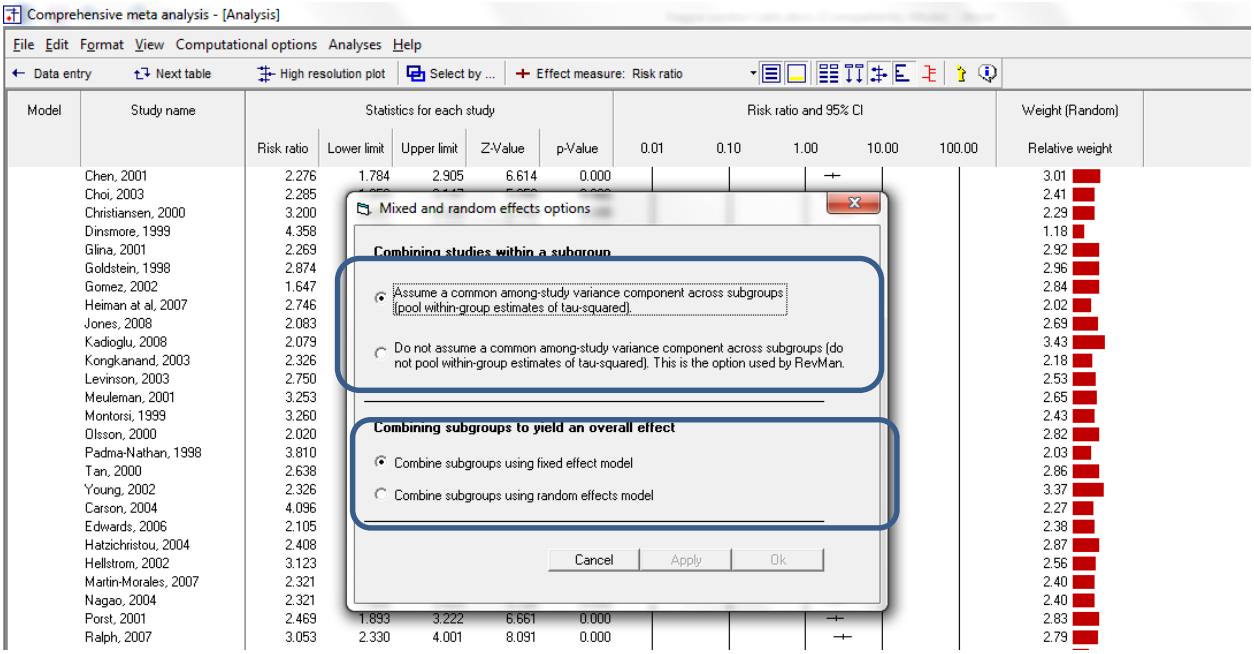
Our plan is to pool the estimates. To select that option

Click Computational options > Mixed and random effects options



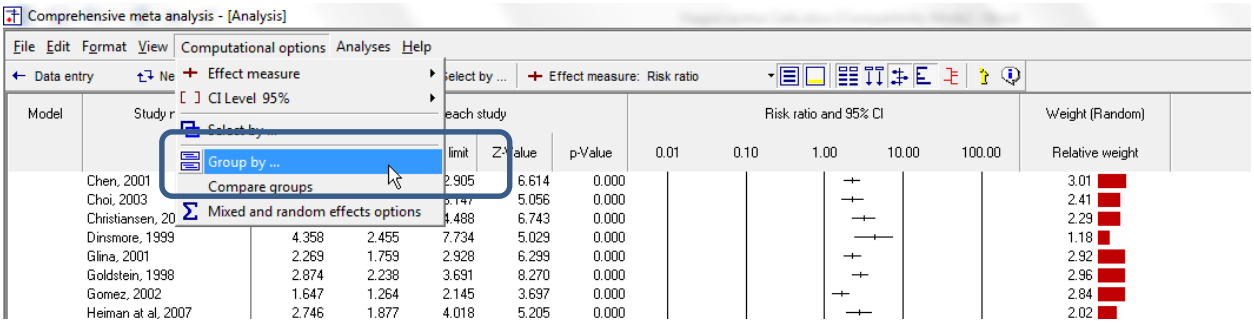
The program displays this wizard

- At the top select the first option, to “Assume a common among-study variance”
- At the bottom select the first option, to “Combine subgroups using a fixed-effect model”

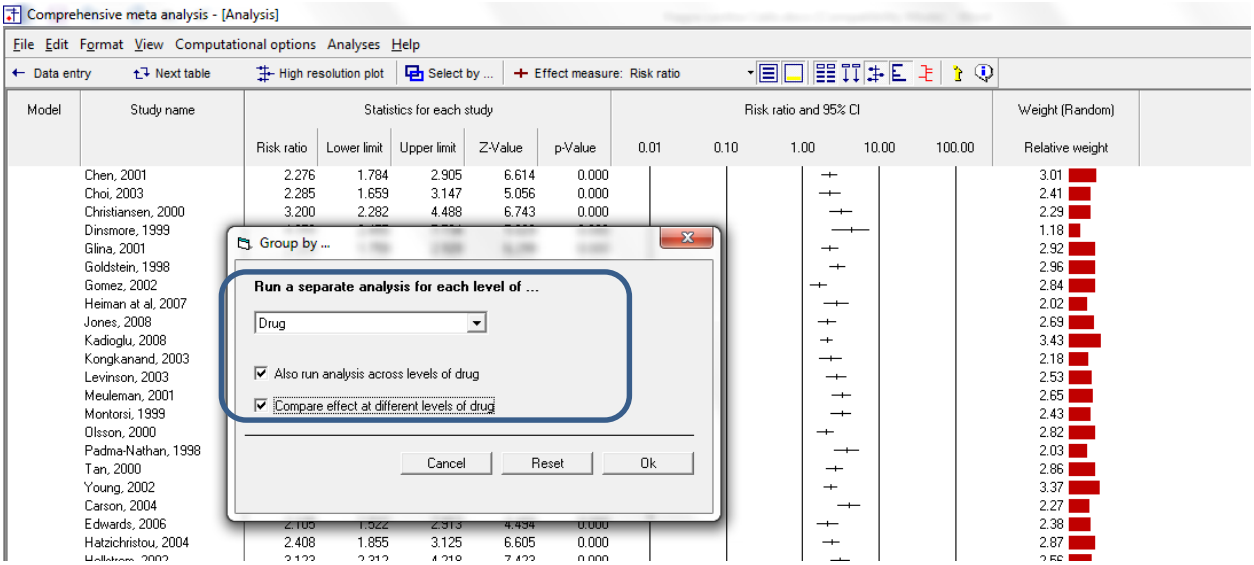


Now, we can tell the program to run the analysis by subgroups.

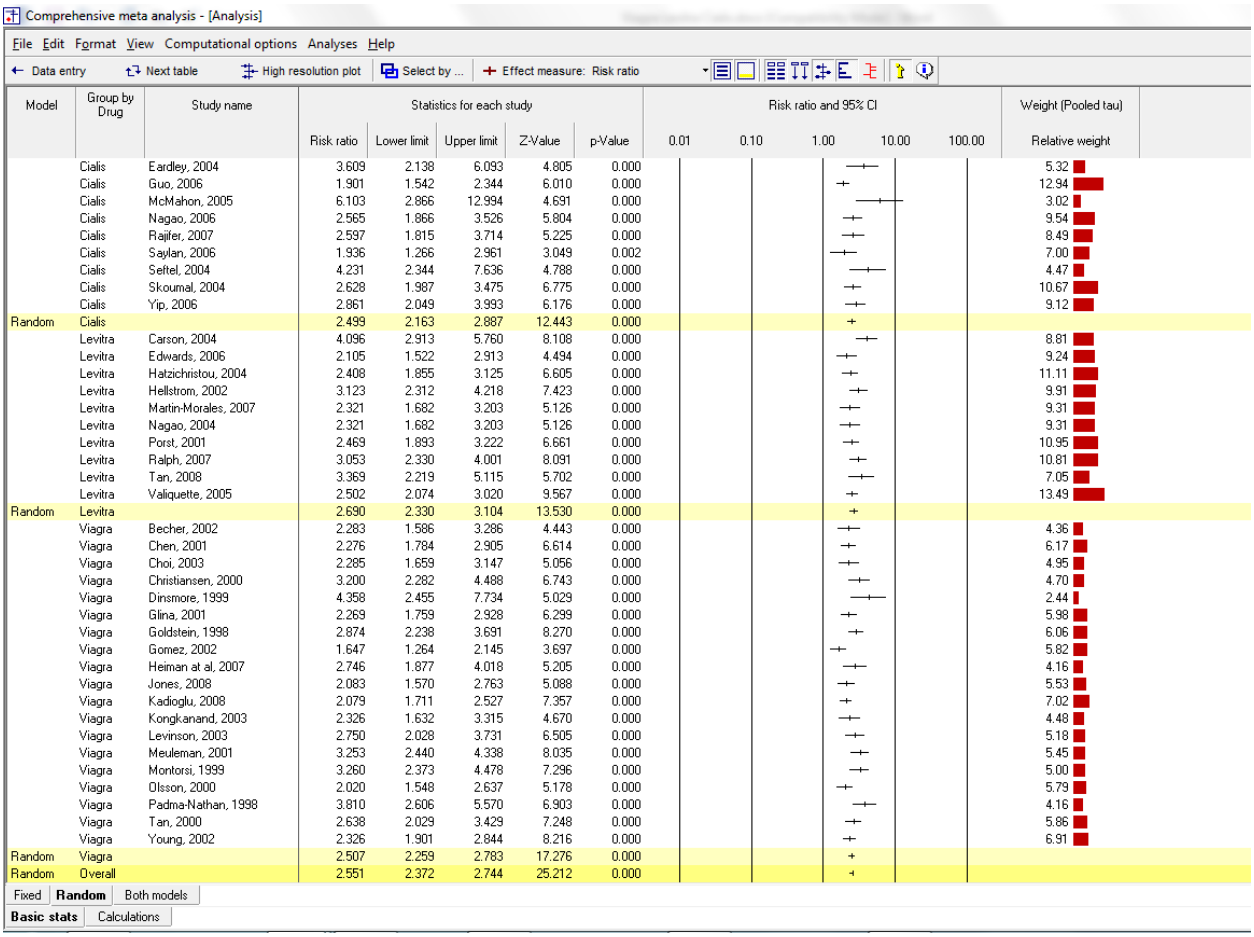
Click Computational options > Group by



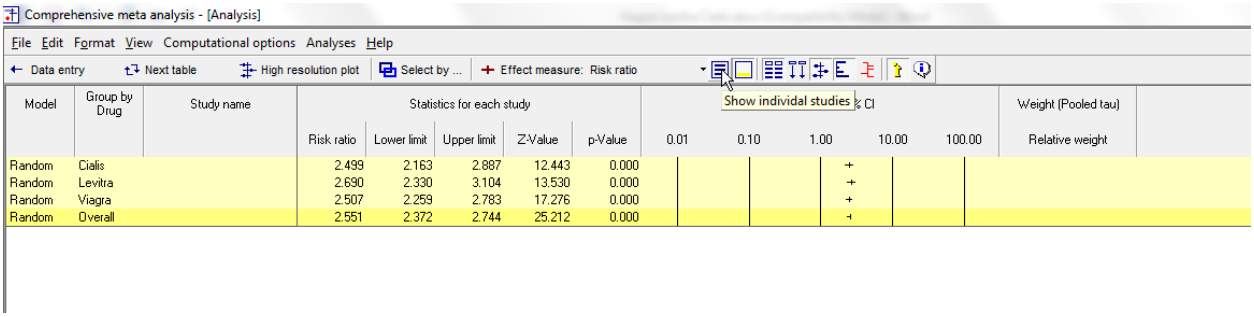
- Select Drug
- Check the two boxes
- Click Ok



The screen should look like this

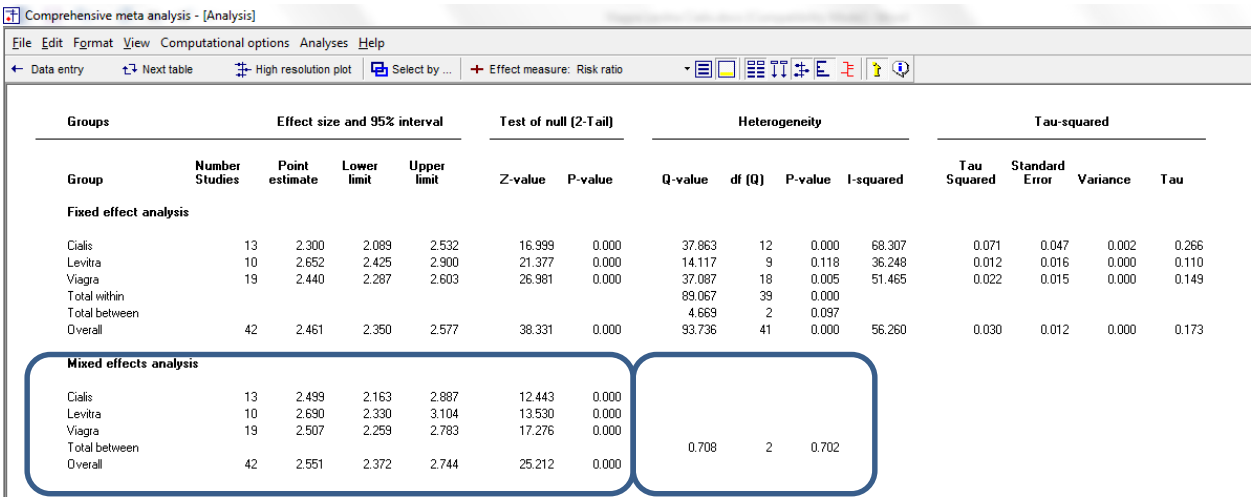


For the Cialis, Levitra, and Cialis studies, the mean risk ratio is 2.499, 2.690, and 2.507, respectively. Click the “Show individual studies” button. This will hide all of the individual studies and display the summary effects only as shown here.



Not only are the three effects very close to each other, but there is substantial overlap in the confidence intervals. Therefore, the differences among the three drugs probably fall within the range that would be expected based on sampling error.

Click Next table



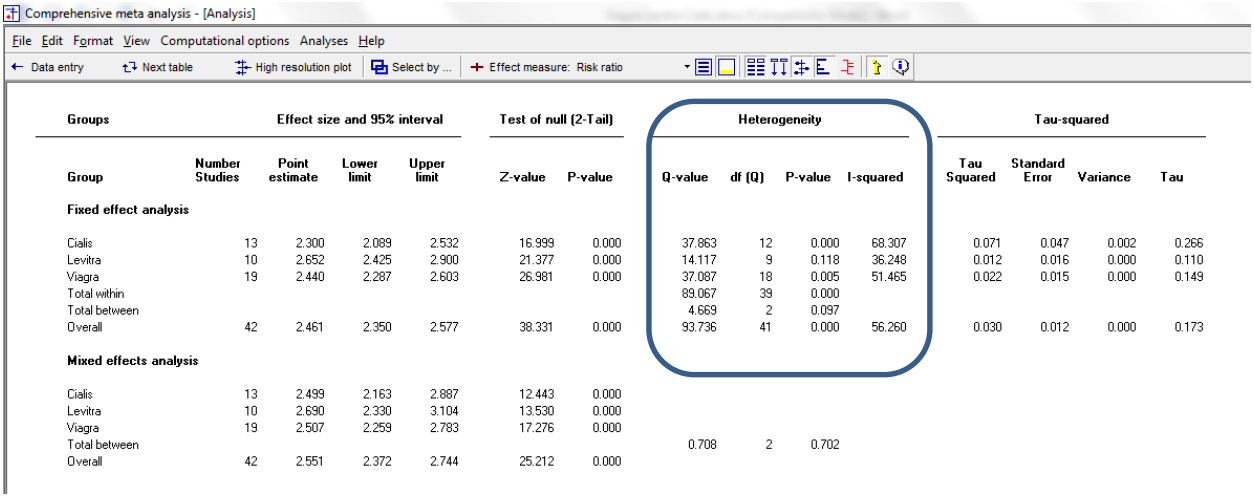
Groups		Effect size and 95% interval			Test of null (2-Tail)		Heterogeneity				Tau-squared			
Group	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
Fixed effect analysis														
Cialis	13	2.300	2.089	2.532	16.999	0.000	37.863	12	0.000	68.307	0.071	0.047	0.002	0.266
Levitra	10	2.652	2.425	2.900	21.377	0.000	14.117	9	0.118	36.248	0.012	0.016	0.000	0.110
Viagra	19	2.440	2.287	2.603	26.981	0.000	37.087	18	0.005	51.465	0.022	0.015	0.000	0.149
Total within							89.067	39	0.000					
Total between							4.669	2	0.097					
Overall	42	2.461	2.350	2.577	38.331	0.000	93.736	41	0.000	56.260	0.030	0.012	0.000	0.173
Mixed effects analysis														
Cialis	13	2.499	2.163	2.887	12.443	0.000								
Levitra	10	2.690	2.330	3.104	13.530	0.000								
Viagra	19	2.507	2.259	2.783	17.276	0.000								
Total between							0.708	2	0.702					
Overall	42	2.551	2.372	2.744	25.212	0.000								

This screen displays two sets of statistics

The table labeled “Fixed-effect analysis” uses fixed-effect weights within subgroups. The table labeled “Mixed-effects analysis” uses random-effects weights within subgroups. This is the table we will use.

As we saw on the prior screen, the risk ratio within the three subgroups is 2.499, 2.690, and 2.507. The effect is statistically significant in each subgroup ($p < 0.001$).

To test the hypothesis that the effect size varies by drug we look to the line labeled “Total between”. The Q-value is 0.708 with 2 df, and the corresponding p-value is 0.702. There is no evidence that the effect differs by drug.



Groups		Effect size and 95% interval			Test of null (2-Tail)		Heterogeneity				Tau-squared			
Group	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
Fixed effect analysis														
Cialis	13	2.300	2.089	2.532	16.999	0.000	37.863	12	0.000	68.307	0.071	0.047	0.002	0.266
Levitra	10	2.652	2.425	2.900	21.377	0.000	14.117	9	0.118	36.248	0.012	0.016	0.000	0.110
Viagra	19	2.440	2.287	2.603	26.981	0.000	37.087	18	0.005	51.465	0.022	0.015	0.000	0.149
Total within							89.067	39	0.000					
Total between							4.669	2	0.097					
Overall	42	2.461	2.350	2.577	38.331	0.000	93.736	41	0.000	56.260	0.030	0.012	0.000	0.173
Mixed effects analysis														
Cialis	13	2.499	2.163	2.887	12.443	0.000								
Levitra	10	2.690	2.330	3.104	13.530	0.000								
Viagra	19	2.507	2.259	2.783	17.276	0.000								
Total between							0.708	2	0.702					
Overall	42	2.551	2.372	2.744	25.212	0.000								

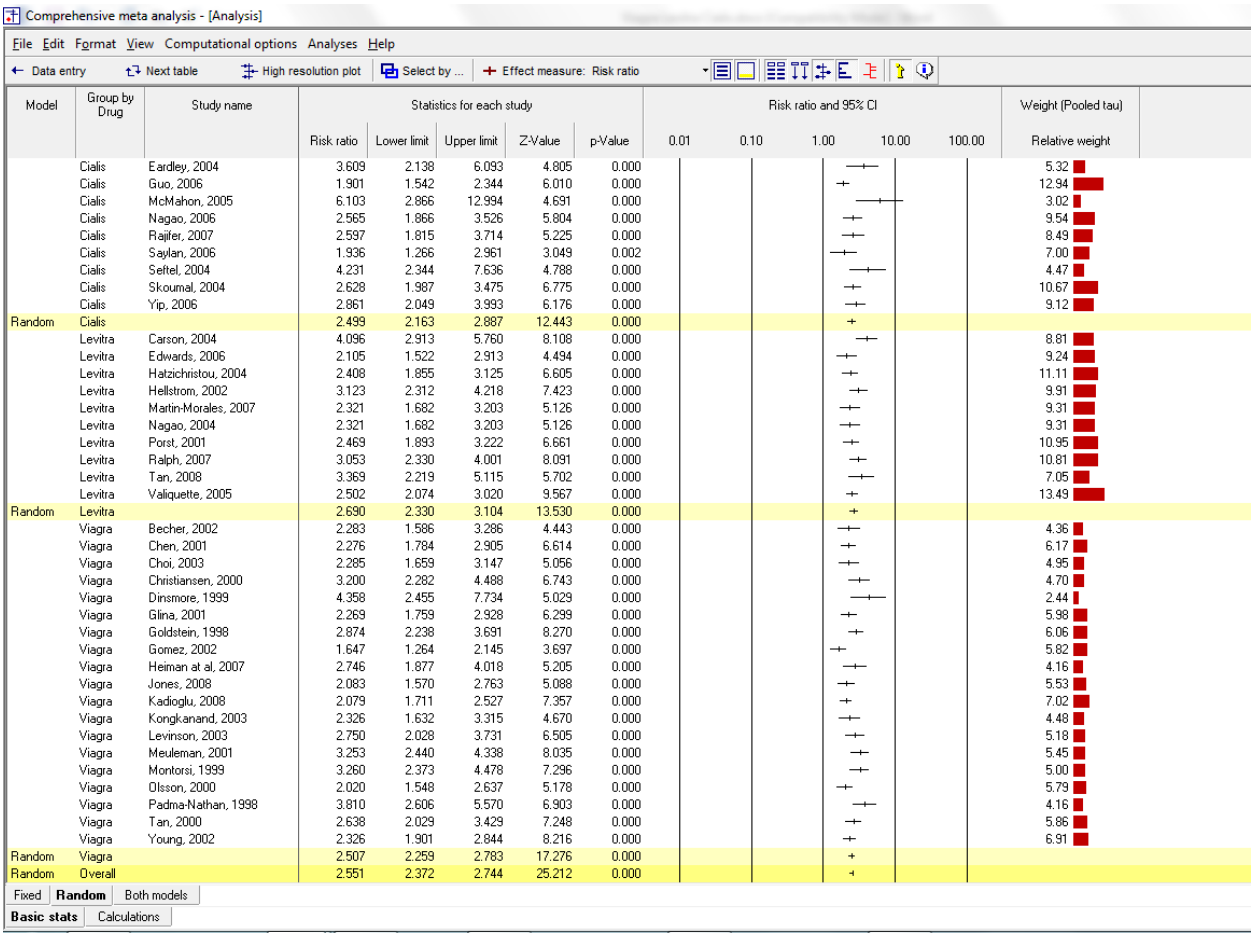
Toward the right of the screen the program displays information about between-study heterogeneity. As was true for the single-group of studies, these statistics are based on FE weights and are therefore displayed in the top section, but they apply to the RE analysis as well.

The omnibus test for heterogeneity within subgroups yields a Q-value of 89.067 with 39 *df* and $p < 0.001$. Therefore, there is evidence of dispersion in true effects within subgroups of studies.

This is are goodness-of-fit test. It asks if the grouping (drug type) explains all of the variance in true effect sizes, or if some true variance remains, even within subgroups. Here, there is evidence of true variance within subgroups.

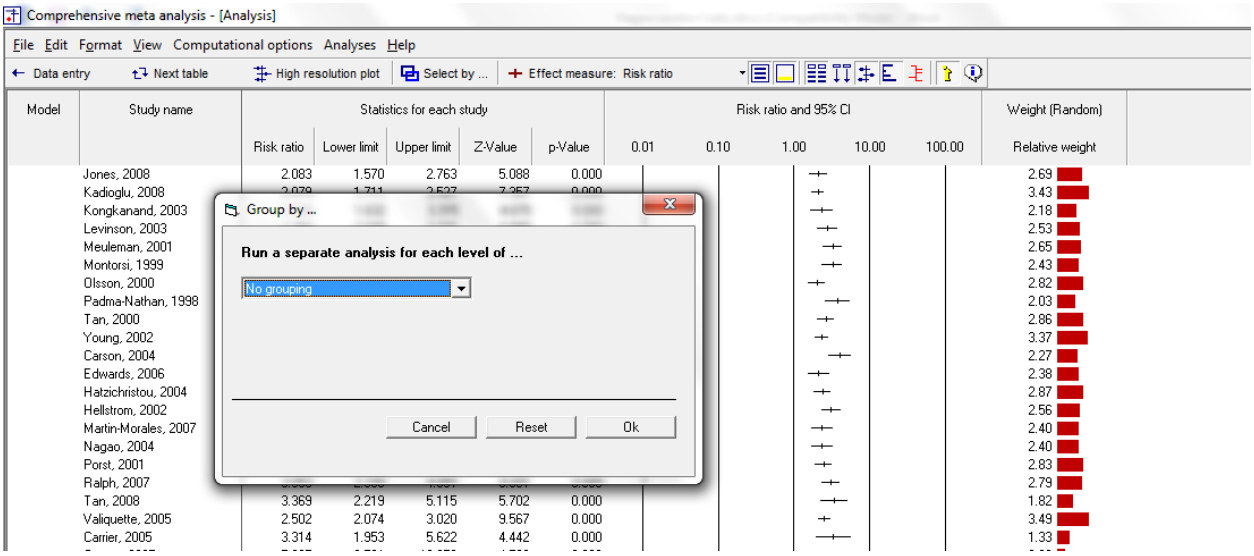
Note that the tests of homogeneity are displayed in the fixed-effect section, even though we're using the random-effects model within subgroups. This is because these tests always are always based on using within-study (fixed-effect) weights. That is, we pose the null (that T^2 is zero) and then see is the variance is consistent with the null.

Click Next table to return to this screen.

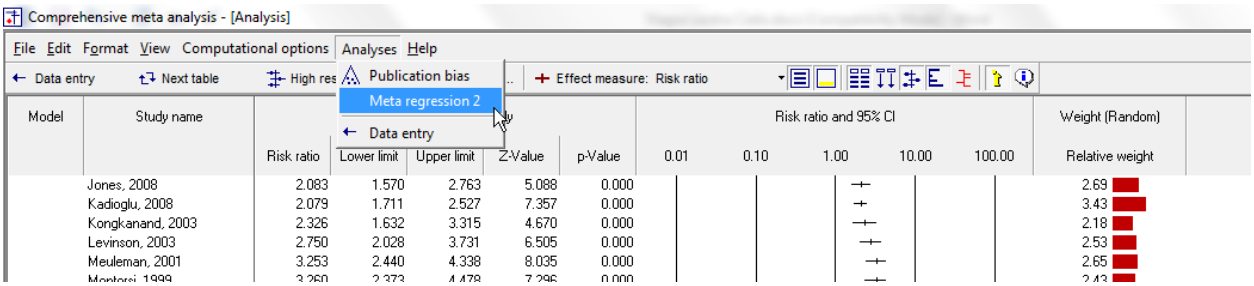


We can run the same analysis using regression

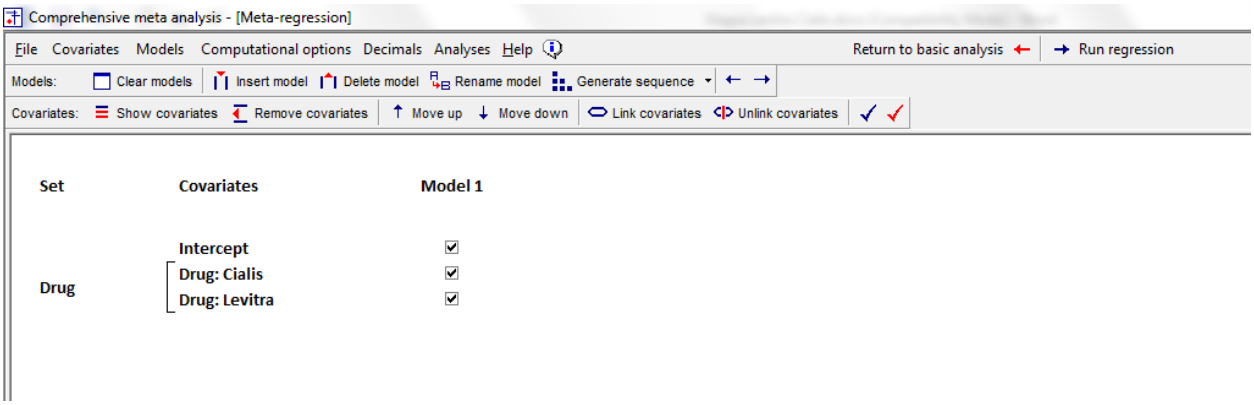
Click Computational options > Group by > No grouping to turn off the grouping



Click Analysis > Meta regression 2

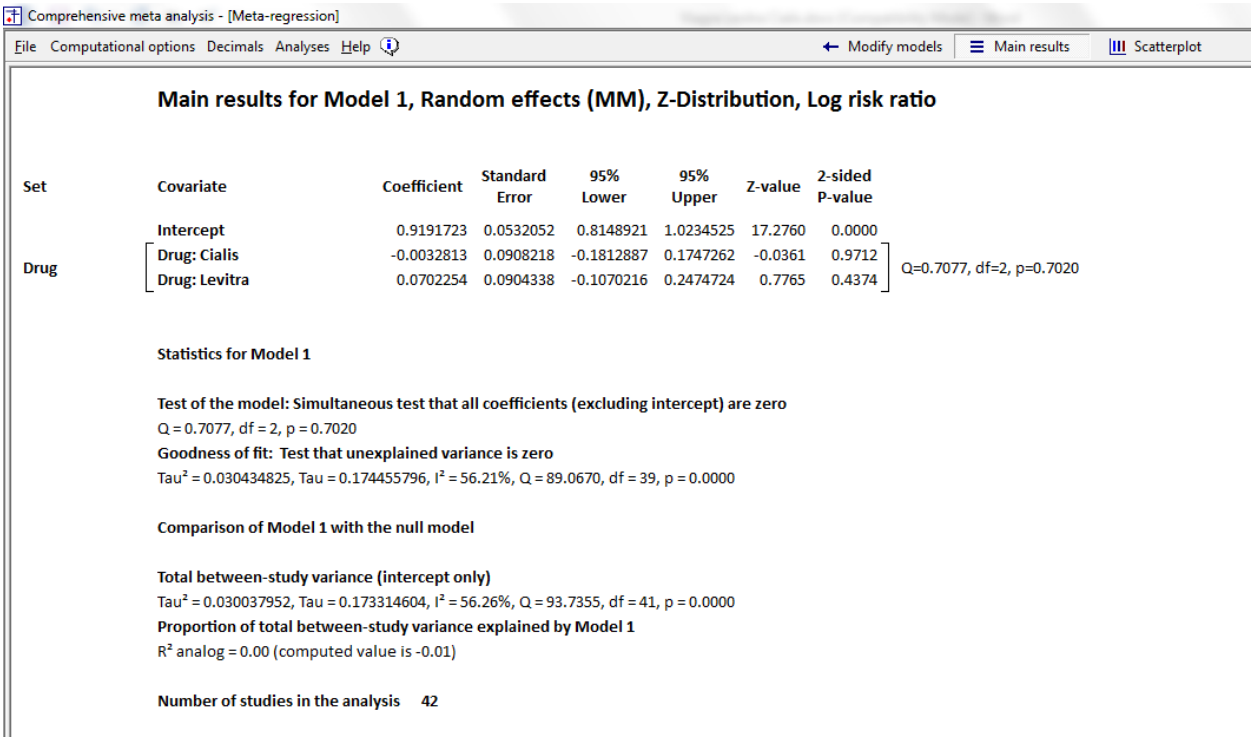


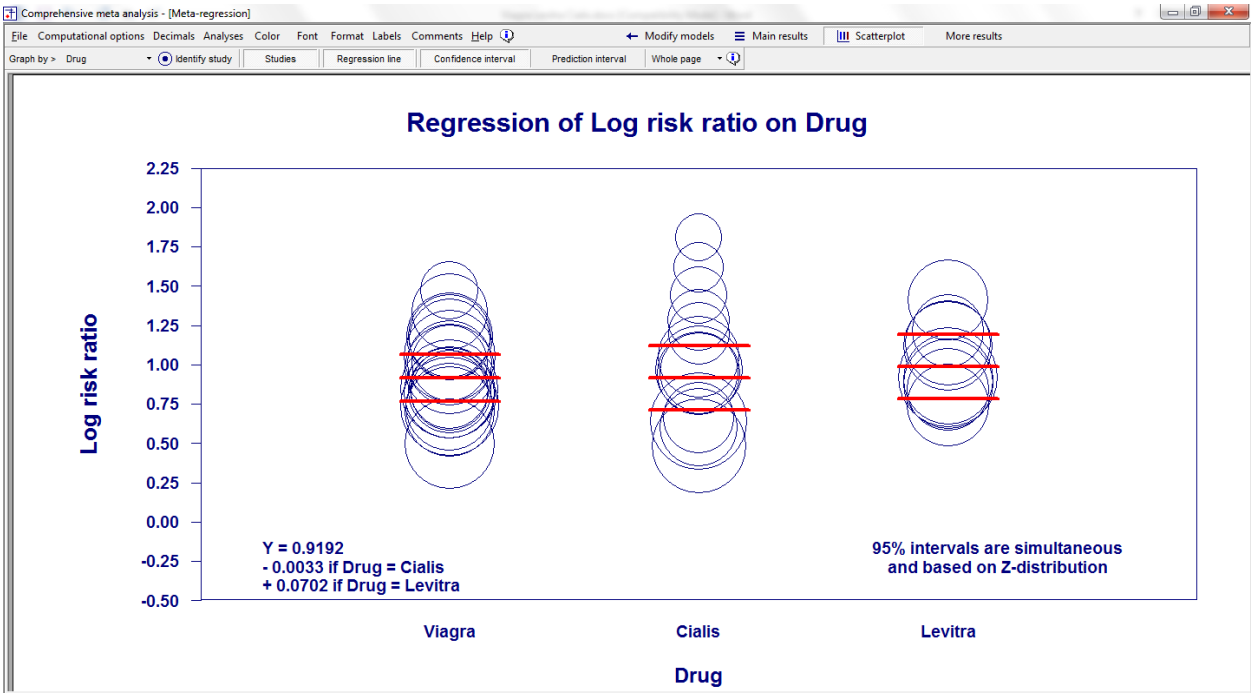
Define a model using Drug as the covariate



The model yields a Q-value of 0.7077 with 2 df and p = 0.7020, which are the same numbers we saw for the subgroups analysis.

The R^2 analog is 0%, which tells us that the drug type explained none of the variance in effect sizes.




Comprehensive meta analysis - [Meta-regression]
File Computational options Decimals Analyses Color Font Format Labels Comments Help
Modify models
Main results
Scatterplot
More results
Graph by > Drug
Identify study
Studies
Regression line
Confidence interval
Prediction interval
Whole page
Regression of Log risk ratio on Drug
Log risk ratio
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
-0.25
-0.50
Y = 0.9192
- 0.0033 if Drug = Cialis
+ 0.0702 if Drug = Levitra
95% intervals are simultaneous
and based on Z-distribution
Viagra
Cialis
Levitra
Drug

Summary

The analysis includes 42 studies. All studies used the same paradigm, where patients suffering from erectile dysfunction were randomly assigned to either drug or placebo. Outcome was self-reports of improved function. The effect size was the risk ratio.

The active drug in some studies was Viagra, in some studies was Levitra, and in some studies was Cialis. We used subgroup analysis to see if the effect size varied by drug.

Does drug improve sexual function?

The mean risk ratio is 2.550, which means that the drug increased the chance of success by a factor of around 2.5.

These studies were sampled from a universe of possible studies defined by certain inclusion/exclusion rules as outlined in the full paper. The confidence interval for the risk ratio is 2.372 to 2.742, which tell us that the mean risk ratio in the universe of studies could fall anywhere in this range. This range does not include a risk ratio of 1.0, which tells us that the mean risk ratio is probably not 1.0.

Similarly, the *Z*-value for testing the null hypothesis (that the mean risk ratio is 1.0) is 25.299, with a corresponding *p*-value is < 0.001. We can reject the null that the drug has no impact on response rate, and conclude that it does lead to a higher likelihood of improved function.

Does the effect size vary across studies?

The *observed* effect size varies somewhat from study to study, but a certain amount of variation is expected due to sampling error. We need to determine if the observed variation falls within the range that can be attributed to sampling error (in which case there is no evidence of variation in true effects), or if it exceeds that range.

The *Q*-statistic provides a test of the null hypothesis that all studies in the analysis share a common effect size. If all studies shared the same effect size, the expected value of *Q* would be equal to the degrees of freedom (the number of studies minus 1).

The *Q*-value is 93.736 with 41 degrees of freedom and p < 0.001. Thus, we can reject the null that the true effect size is the same in all studies. Rather, the true effect size varies from study to study.

The I^2 statistic tells us what proportion of the observed variance reflects differences in true effect sizes rather than sampling error. I^2 is 56.26, which tells us that about 56% of the variance in observed effects reflects variance in true effects. If we could somehow plot the true effects rather than the observed effects, the variance in the new plot would be about 56% as large as the variance in the current plot.

T^2 is the variance of true effect sizes (in log units). Here, T^2 is 0.030. *T* is the standard deviation of true effects (in log units). Here, *T* is 0.173.

Does the effect size vary by Drug?

We ran the analysis by subgroup, where studies were grouped based on the kind of drug used. The mean effect was approximately the same for Cialis, Levitra, and Viagra (risk ratios of 2.499, 2.690, and 2.507). The test to compare the three yields a Q-value of 0.708 with 1 df and p = 0.702. Thus, there was no evidence that any one of the drugs was more effective than the others.