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Department of  
Health Sciences

# An interactive web application to aid diagnostic test accuracy meta-analysis

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**NIHR CRSU**

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Health Research

# Conflicts of Interest

I have no actual or potential conflicts of interest in relation to this presentation.

# Acknowledgements

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Department of Health Disclaimer:

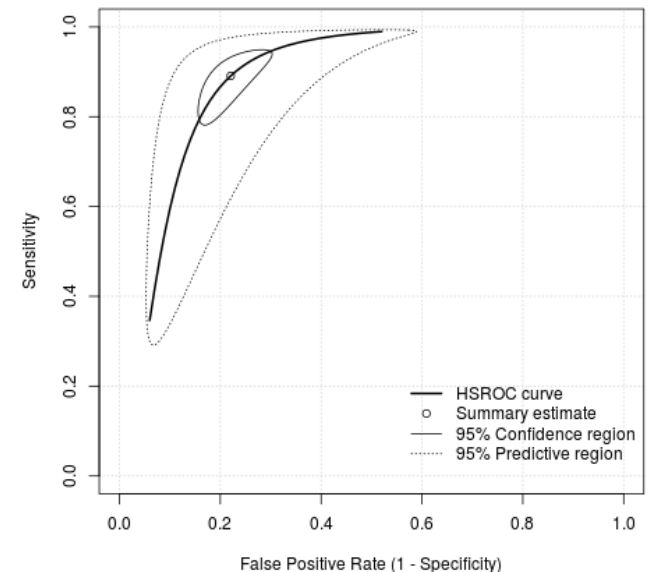
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# Background

- Diagnostic tests generally split individuals into healthy or diseased
- Routinely used to guide treatment decisions
- Some studies aim to identify a new diagnostic test that is still as acceptably accurate as the “gold standard” but less costly or invasive
- Accuracy of a diagnostic test often assessed by comparing to the “gold standard” in terms of sensitivity and specificity

# Meta-Analysis of DTA studies

- Meta-analysis of DTA studies synthesises sensitivity and specificity
  - Important to take correlation into account
- Often performed using bivariate or hierarchical summary receiver operating curve (HSROC) models
- Results often presented as a summary receiver operating curve (SROC)
- Current software:
  - Stata (metandi)
  - R (mada, lme4, bamdit)
  - SAS (MetaDAS)
  - All require some form of expert knowledge



# What about RevMan?

- From the Cochrane Handbook for Systematic Reviews of DTA:

“The Moses-Littenberg model is used in RevMan to provide reviewers with the facility to undertake purely exploratory analyses based on SROC curves without needing to export data out of RevMan. **Because of the limitations of the Moses-Littenberg method, RevMan does not provide parameter estimates or standard errors from this model** as inferences should be based on hierarchical models that take separate account of within study sampling error and additional unexplained heterogeneity between studies.”

- To fit bivariate or HSROC models need to import model parameters from other software such as Stata, SAS or R

# Aim

To develop a freely available web-based “point and click” interactive online application which allows users to input their own data and conduct meta-analyses of DTA studies including sensitivity analyses

# App Development

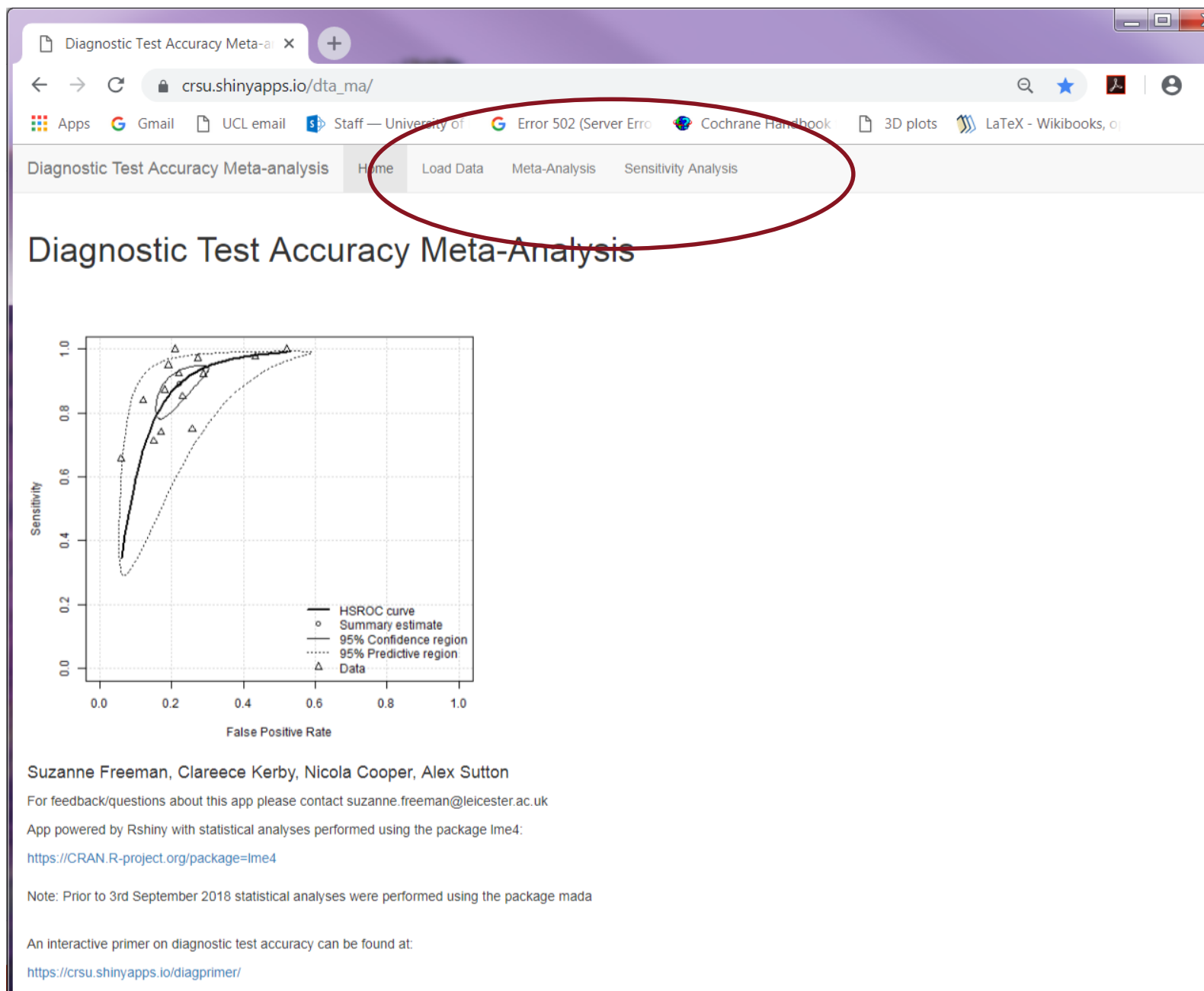
- R and the packages Shiny and lme4
  - Shiny used to create the online application
  - lme4 used for the statistical analysis (bivariate binomial model of Chu & Cole)
- Application hosted on the shinyapps server available at:  
[https://crsu.shinyapps.io/dta\\_ma/](https://crsu.shinyapps.io/dta_ma/)
- Available to all users with an internet browser
  - No specialist software required

# Example

- Fourteen studies assessing the use of the AUDIT-C (Alcohol Use Disorders Identification Test-Consumption) questionnaire for identifying patients with an unhealthy alcohol use problem

author	year	TP	FN	FP	TN
Aalto	2006	47	9	101	738
Aertgeerts01	2001	126	51	272	1543
Aertgeerts02	2002	19	10	12	192
Bradley03	2003	36	3	78	276
Bradley07	2007	130	19	211	959
Bush	1998	84	2	68	89





Diagnostic Test Accuracy Meta-anal

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Diagnostic Test Accuracy Meta-analysisHomeLoad DataMeta-AnalysisSensitivity Analysis

Please select a file

SelectNo file selected

Default maximum file size is 5MB

File options

☒ First row as column headings

File Delimiter

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File UploadData for Analysis

Please select a file to upload

The file should contain six columns. Labelling of columns is case sensitive.

The **first** column should be labelled **author** and contain the name of the study author. The author name must be unique for each study.

The **second** column should be labelled **year** and contain the year of publication.

The **third** column should be labelled **TP** and contain the number of patients with a true positive test result.

The **fourth** column should be labelled **FN** and contain the number of patients with a false negative test result.

The **fifth** column should be labelled **FP** and contain the number of patients with a false positive test result.

The **sixth** column should be labelled **TN** and contain the number of patients with a true negative test result.

An example of this structure can be seen in the 'Data for Analysis' tab.

The default dataset is a subset of data from a study on unhealthy alcohol use and alcohol use disorders (Kriston et al. Ann Intern Med. 2008; 149: 879). The dataset consists of fourteen studies assessing the use of the AUDIT-C (Alcohol Use Disorders Identification Test-Consumption) questionnaire for identifying patients with an unhealthy alcohol use problem.

Note: The default dataset, pre-loaded on the 'Data for Analysis' tab will be used for analysis if no file is selected. The 'Data for Analysis' tab will automatically update once a file is successfully loaded.

Excel files should be saved in csv format and the separator option 'comma' selected for upload.

Diagnostic Test Accuracy Meta-analysis

Home Load Data Meta-Analysis Sensitivity Analysis

Please select a file

Select No file selected

Default maximum file size is 5MB

File options

☒ First row as column headings

File Delimiter

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☐ Semicolon  
☐ Tab  
☐ Space

File Upload

Data for Analysis

author	year	TP	FN	FP	TN
Aalto	2006	47	9	101	738
Aertgeerts01	2001	126	51	272	1543
Aertgeerts02	2002	19	10	12	192
Bradley03	2003	36	3	78	276
Bradley07	2007	130	19	211	959
Bush	1998	84	2	68	89
Gomez	2006	68	0	112	423
Gordon	2001	752	0	3226	2977
Gual	2002	59	5	55	136
Rumpf	2002	142	50	571	2788
Seale	2006	137	24	107	358
Selin	2006	57	3	103	437
Tsai	2005	34	1	21	56
Tuunanen	2007	152	51	88	254

Diagnostic Test Accuracy Meta-analysis Home Load Data Meta-Analysis Sensitivity Analysis

## Meta-Analysis of Diagnostic Test Accuracy Studies

### Options for ROC Curve tab

- ☒ Data Points
- ☒ SROC curve
- ☐ Extrapolate SROC curve

### Bivariate model options

- ☒ Summary point
- ☒ 95% Confidence region
- ☒ 95% Predictive region

### Options for Statistics tab

- ☒ Sensitivity
- ☒ Specificity
- ☒ False Positive Rate
- ☐ Correlation
- ☐ HSROC parameters
- ☐ Diagnostic Odds Ratio
- ☐ Likelihood Ratios

Study-level Outcomes

ROC Curve

Statistics

Show 30 entries

Search:

	Author	Year	TP	FN	FP	TN	N	Sensitivity	Specificity	FPR
1	Aalto	2006	47	9	101	738	895	0.839	0.880	0.120
2	Aertgeerts01	2001	126	51	272	1543	1992	0.712	0.850	0.150
3	Aertgeerts02	2002	19	10	12	192	233	0.655	0.941	0.059
4	Bradley03	2003	36	3	78	276	393	0.923	0.780	0.220
5	Bradley07	2007	130	19	211	959	1319	0.872	0.820	0.180
6	Bush	1998	84	2	68	89	243	0.977	0.567	0.433
7	Gomez	2006	68	0	112	423	603	1.000	0.791	0.209
8	Gordon	2001	752	0	3226	2977	6955	1.000	0.480	0.520
9	Gual	2002	59	5	55	136	255	0.922	0.712	0.288
10	Rumpf	2002	142	50	571	2788	3551	0.740	0.830	0.170
11	Seale	2006	137	24	107	358	626	0.851	0.770	0.230
12	Selin	2006	57	3	103	437	600	0.950	0.809	0.191
13	Tsai	2005	34	1	21	56	112	0.971	0.727	0.273
14	Tuunanen	2007	152	51	88	254	545	0.749	0.743	0.257

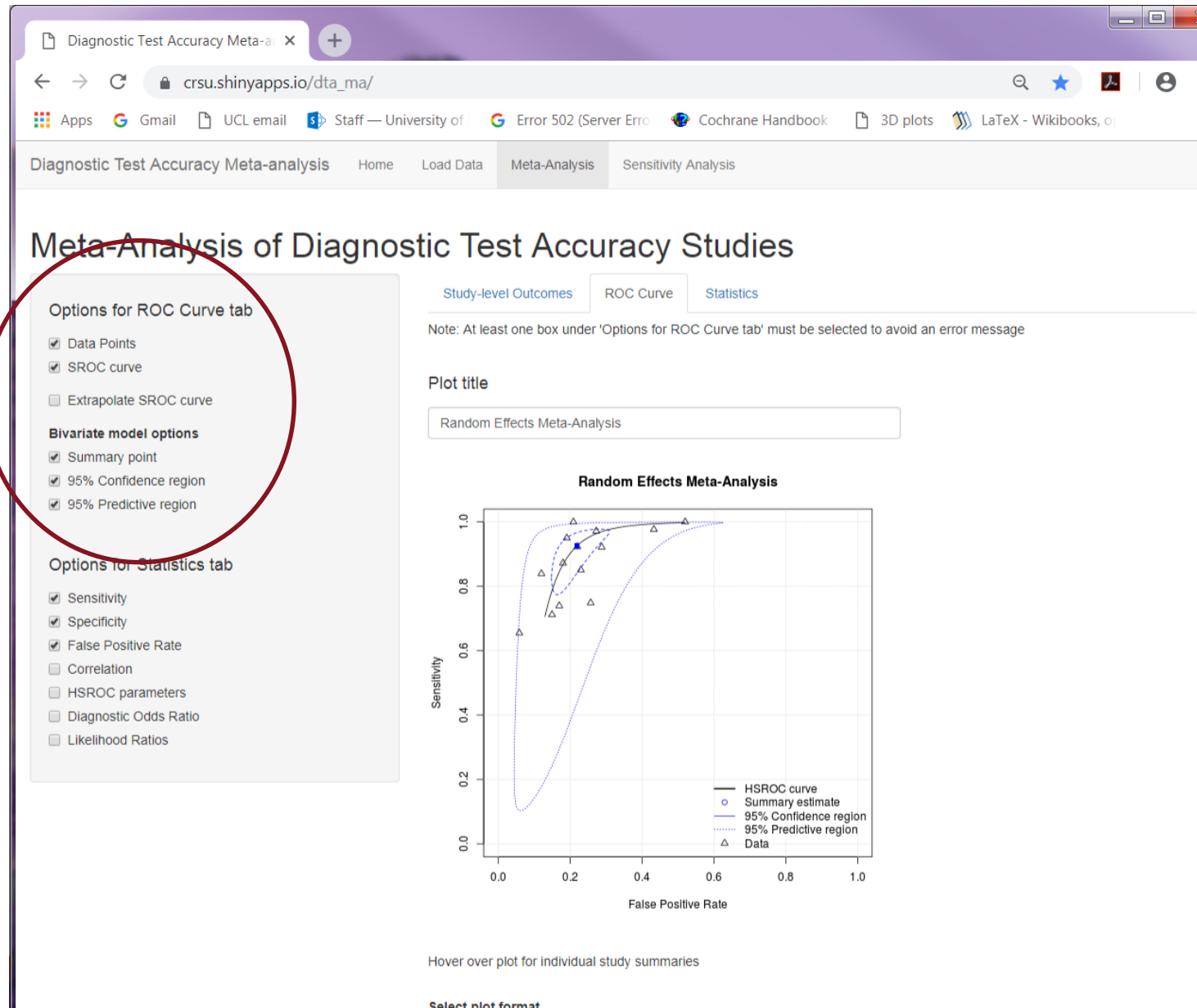
Showing 1 to 14 of 14 entries

Previous

1

Next

Download Table



### Options for ROC Curve tab

- ☒ Data Points
- ☒ SROC curve
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### Bivariate model options

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- ☒ 95% Confidence region
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- ☐ Diagnostic Odds Ratio
- ☐ Likelihood Ratios

Study-level Outcomes

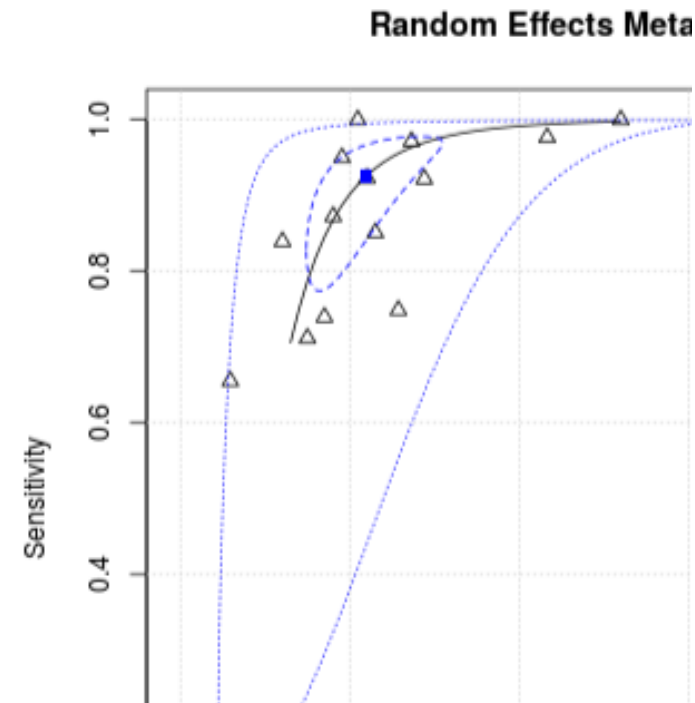
ROC Curve

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Note: At least one box under 'Options for ROC Curve' must be checked.

### Plot title

Random Effects Meta-Analysis



Diagnostic Test Accuracy Meta-analysis

Home Load Data Meta-Analysis Sensitivity Analysis

## Meta-Analysis of Diagnostic Test Accuracy Studies

### Options for ROC Curve tab

- ☒ Data Points
- ☒ SROC curve
- ☐ Extrapolate SROC curve

### Bivariate model options

- ☒ Summary point
- ☒ 95% Confidence region
- ☒ 95% Predictive region

### Options for Statistics tab

- ☒ Sensitivity
- ☒ Specificity
- ☒ False Positive Rate
- ☒ Correlation
- ☒ HSROC parameters
- ☒ Diagnostic Odds Ratio
- ☒ Likelihood Ratios

Study-level Outcomes ROC Curve Statistics

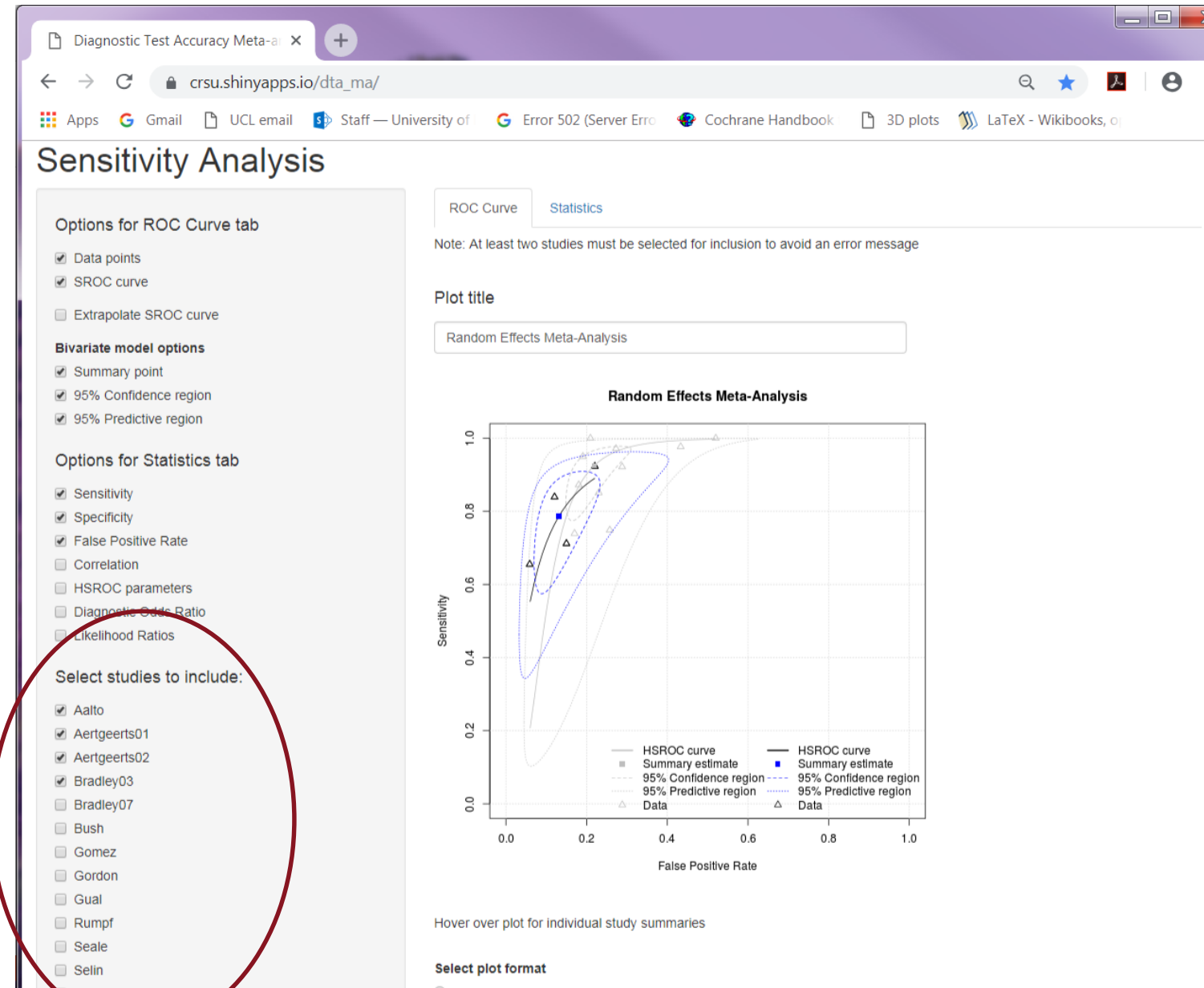
Parameter	Estimate	2.5%	97.5%
Sensitivity	0.925	0.834	0.968
Specificity	0.781	0.719	0.833
False Positive Rate	0.219	0.167	0.281
Correlation	-0.746		
$\theta$	-0.250		
$\lambda$	3.612		
$\beta$	-0.958		
$\sigma_{\theta}$	0.904		
$\sigma_{\alpha}$	0.378		
Diagnostic Odds Ratio	44.050	13.706	74.394
Log Likelihood Ratio +ve	4.231	3.327	5.135
Log Likelihood Ratio -ve	0.096	0.021	0.171

Download Table

## Options for Statistics tab

- ☒ Sensitivity
- ☒ Specificity
- ☒ False Positive Rate
- ☒ Correlation
- ☒ HSROC parameters
- ☒ Diagnostic Odds Ratio
- ☒ Likelihood Ratios

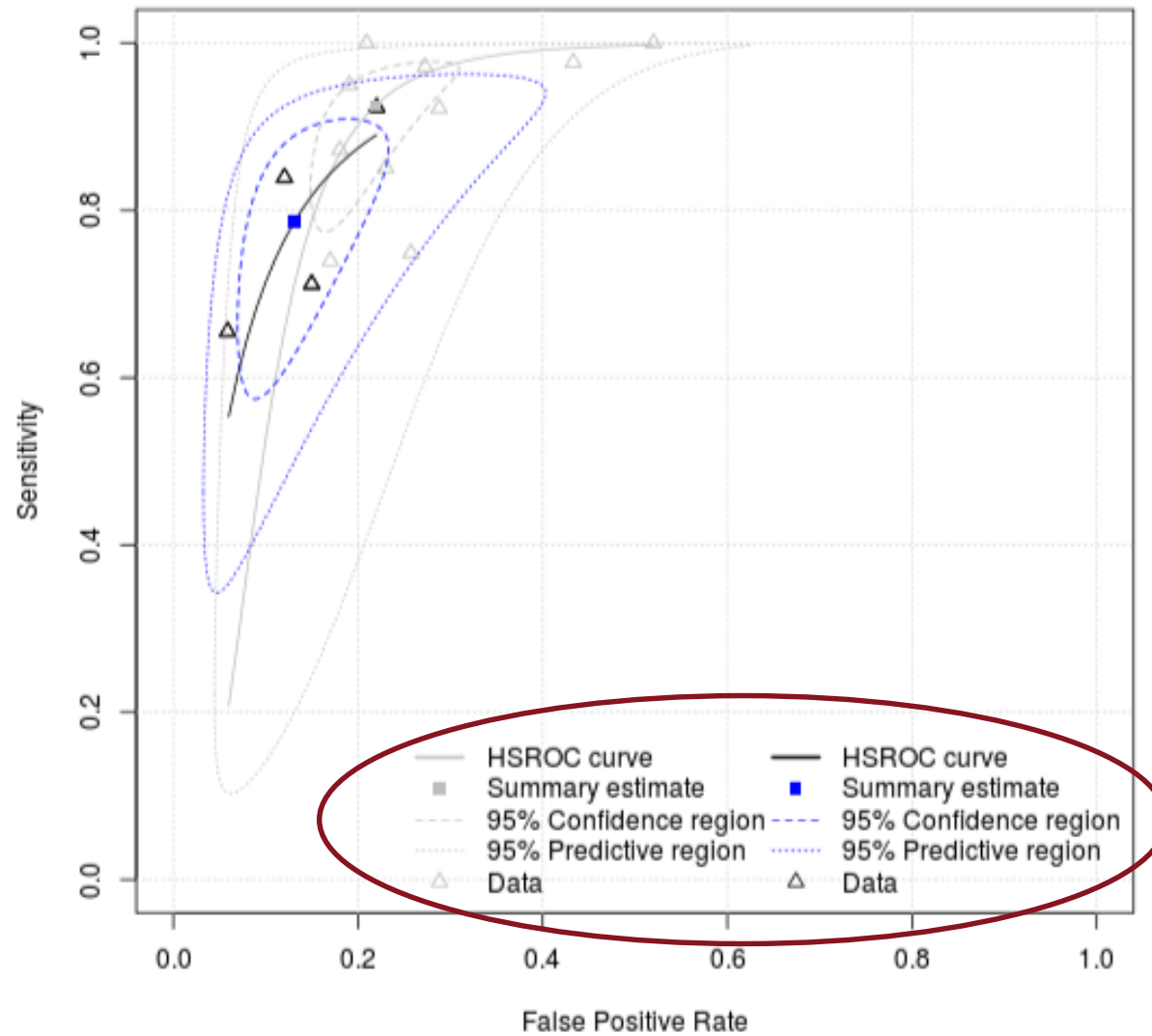




Select studies to include:

- ☒ Aalto
- ☒ Aertgeerts01
- ☒ Aertgeerts02
- ☒ Bradley03
- ☐ Bradley07
- ☐ Bush
- ☐ Gomez
- ☐ Gordon
- ☐ Gual
- ☐ Rumpf
- ☐ Seale
- ☐ Selin
- ☐ Tsai
- ☐ Tuunanen

### Random Effects Meta-Analysis



Diagnostic Test Accuracy Meta-analysis

Home Load Data Meta-Analysis Sensitivity Analysis

## Sensitivity Analysis

### Options for ROC Curve tab

- ☒ Data points
- ☒ SROC curve
- ☐ Extrapolate SROC curve

### Bivariate model options

- ☒ Summary point
- ☒ 95% Confidence region
- ☒ 95% Predictive region

### Options for Statistics tab

- ☒ Sensitivity
- ☒ Specificity
- ☒ False Positive Rate
- ☐ Correlation
- ☐ HSROC parameters
- ☐ Diagnostic Odds Ratio
- ☐ Likelihood Ratios

### Select studies to include:

- ☒ Aalto
- ☒ Aertgeerts01
- ☒ Aertgeerts02
- ☒ Bradley03
- ☐ Bradley07
- ☐ Bush
- ☐ Gomez
- ☐ Gordon
- ☐ Gual
- ☐ Dunn

ROC Curve Statistics

### All studies

Parameter	Estimate	2.5%	97.5%
Sensitivity	0.925	0.834	0.968
Specificity	0.781	0.719	0.833
False Positive Rate	0.219	0.167	0.281

### Selected studies only

Parameter	Estimate	2.5%	97.5%
Sensitivity	0.786	0.645	0.881
Specificity	0.869	0.802	0.916
False Positive Rate	0.131	0.084	0.198

Download Table

ROC Curve

Statistics

### All studies

Parameter	Estimate	2.5%	97.5%
Sensitivity	0.925	0.834	0.968
Specificity	0.781	0.719	0.833
False Positive Rate	0.219	0.167	0.281

### Selected studies only

Parameter	Estimate	2.5%	97.5%
Sensitivity	0.786	0.645	0.881
Specificity	0.869	0.802	0.916
False Positive Rate	0.131	0.084	0.198

 Download Table

# Conclusions

- We developed a freely available interactive online application which meta-analyses DTA studies, produces the SROC plot and allows sensitivity analyses to be conducted
- All tables and plots can be downloaded
- We think we achieved our initial aim however...To do list:
  - Subgroup analysis/covariates
  - Move list of included studies to separate panel (sensitivity analysis page)
  - Test how much data the app can handle & different internet browsers
  - Compatibility with RevMan

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