

Basic of meta-analysis in R

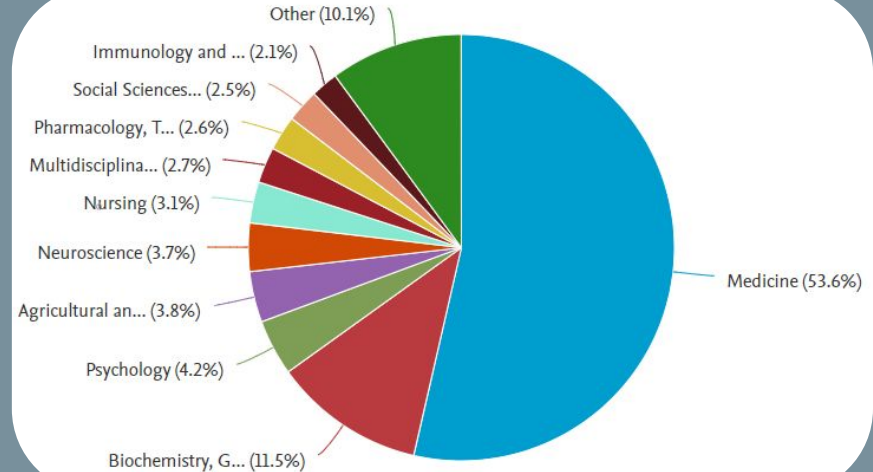
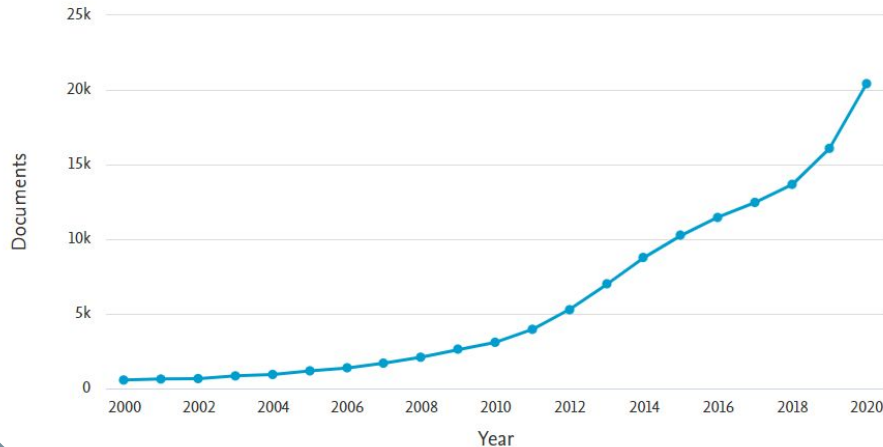


Tengku Muhd Hanis Mokhtar
PhD student, USM
August 7, 2021

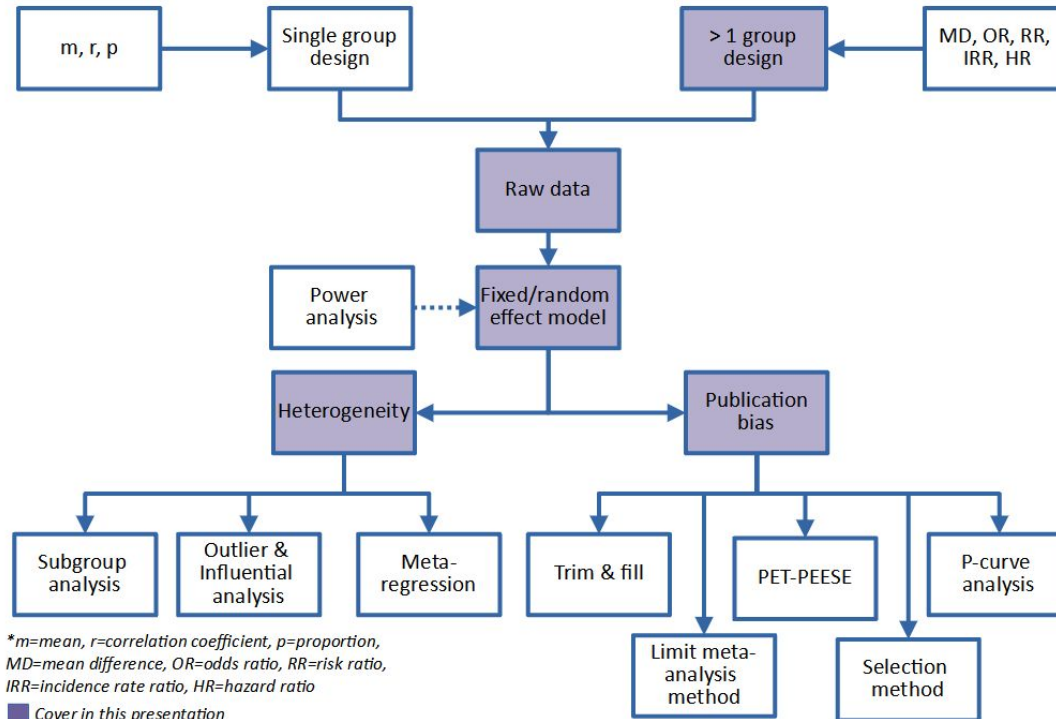
Background

- Meta-analysis:
 - Statistical methods used to combine individual results into pooled result
- From Scopus database (20-07-2021): 144, 904 documents

Documents by year



General framework



Basic jargons

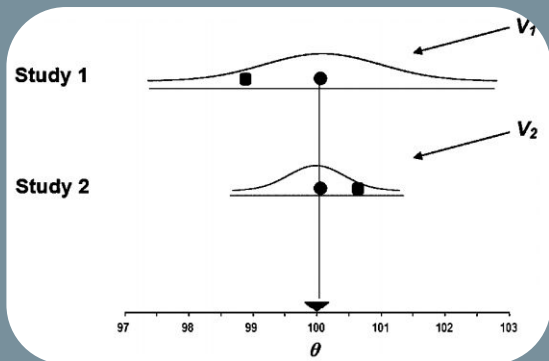
- Fixed vs random effect model
- Between-study heterogeneity
- Publication bias
- Forest plot
- Funnel plot



Basic jargons (cont.)

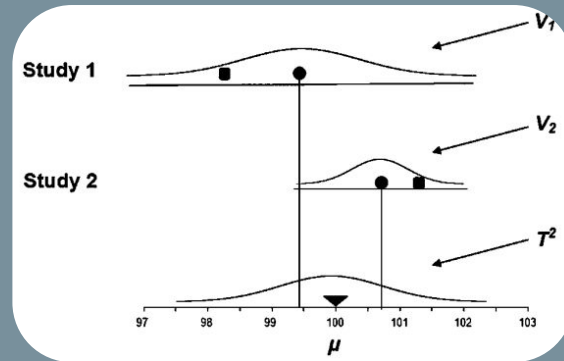
Fixed effect:

- One true effect size
- Estimate one true effect size



Random effect:

- True effects varies (ie; distribution of true effect sizes)
- Estimates mean of the distribution of true effects



(Borenstein et al., 2010)

Basic jargons (cont.)

Heterogeneity (almost always refer to between study heterogeneity):

- Variation in study outcomes between studies (statistical heterogeneity)
- Measurement: Q -statistics, T^2 , I^2 , H^2
- Other types of heterogeneity refer to Rucker et al., 2008

Publication bias:

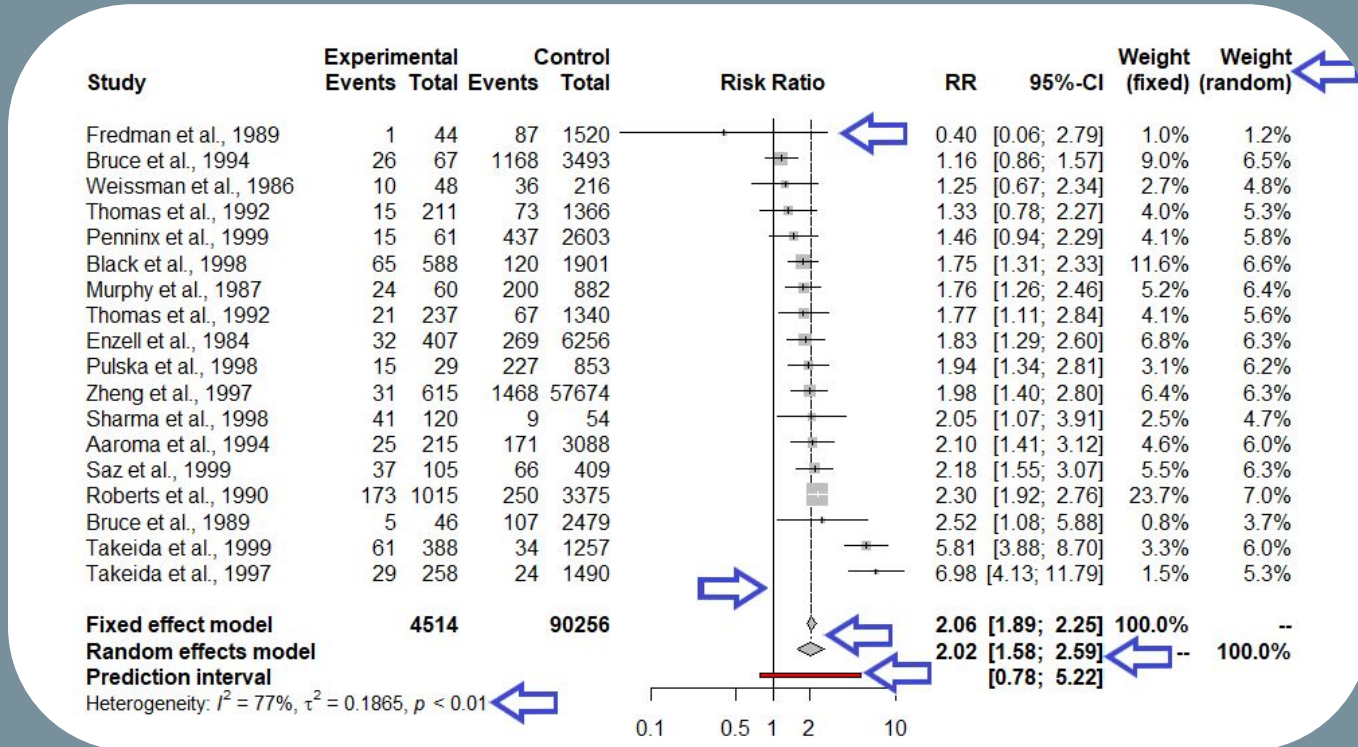
- Studies being published depends on the its result
- Consequences:
 - Overestimate the effect size
 - Overlook negative effect size
 - Reinforces invalid theories

Basic jargons (cont.)

- Publication bias tested using:
 - Visual: Funnel plot
 - Statistical (min k=10):
 - Classical: Begg, Egger (default), Thompson
 - Binary outcome: Peters, Harbord (default for OR), Schwarzer, Deeks, etc
 - SMD (for Hedges' g): Pustejovsky

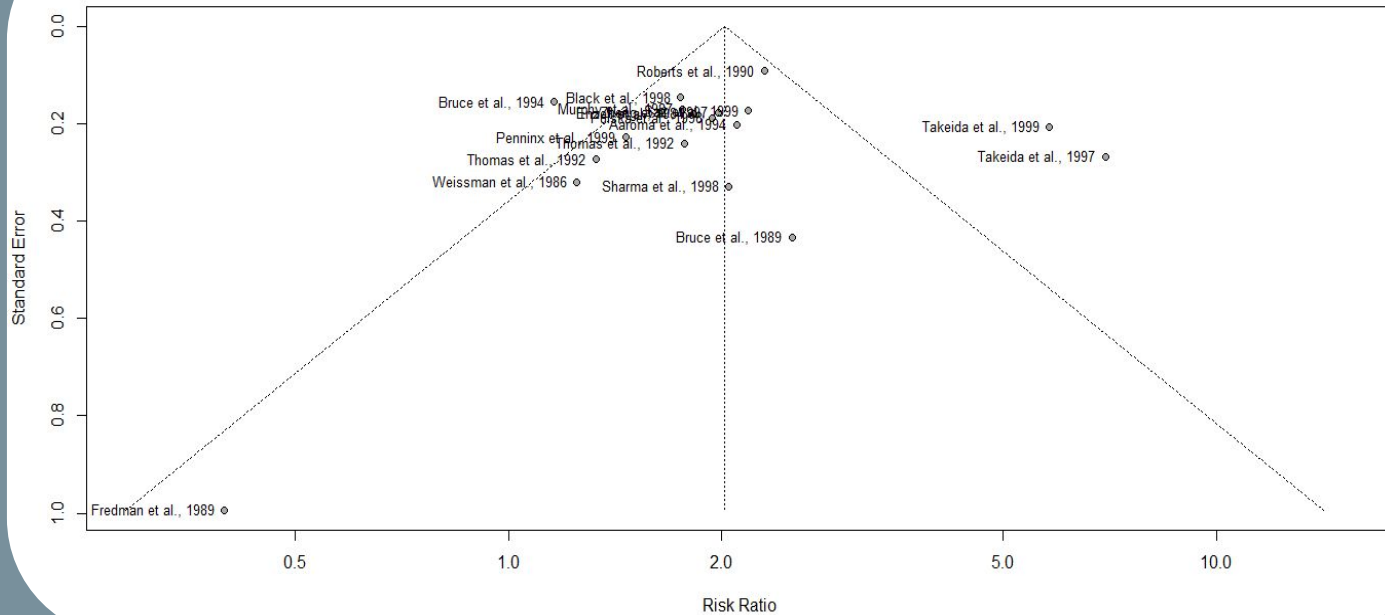
Basic jargons (cont.)

Forest plot



Basic jargons (cont.)

Funnel plot



Advanced method

- Variation of visualization:
 - Forest plot equivalent: Drapery plot
 - Variant of funnel plot: Contour-enhanced funnel plot
- Meta-regression
- Subgroup analysis
- Outlier and influential diagnostic (rule of thumb; $I^2 > 50\%$)
- Publication bias related method
- etc

Type of meta-analysis

1. **“General” meta-analysis (Intervention/observational study)**
 - Single group design: Pool mean, correlation coefficient, prevalence/proportion
 - >1 group design: Pool mean difference, OR, RR, IRR, HR
2. "Multilevel" meta-analysis
 - There is 3rd level
3. Network meta-analysis
 - Compare several treatment effect directly and indirectly
4. Dose response meta-analysis
 - Quantify level of exposure effect to response

Type of meta-analysis (cont.)

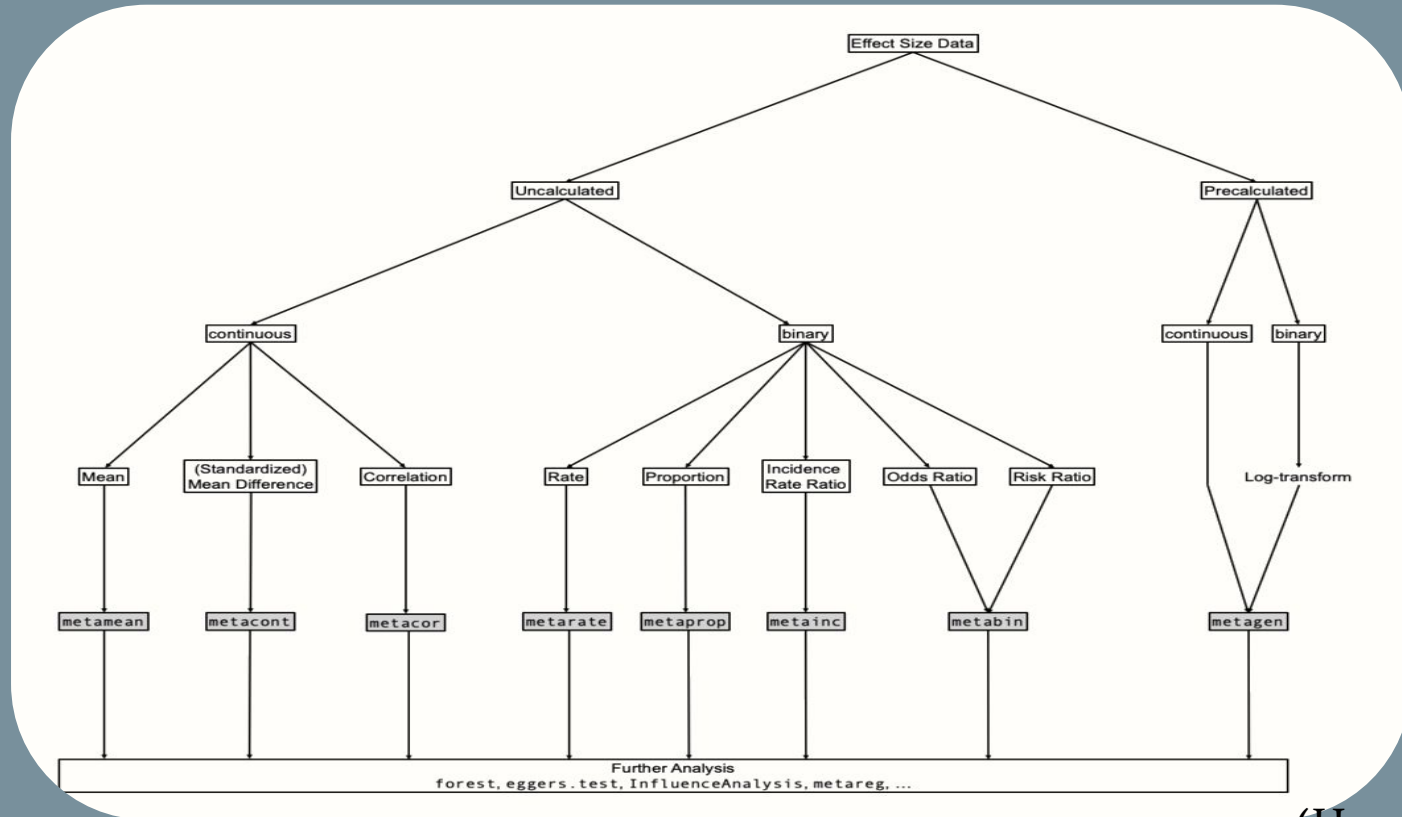
5. Diagnostic test accuracy meta-analysis
 - Pool sensitivity, specificity, AUC
6. Multivariate/Anova/SEM meta-analysis
7. Bayesian approach
8. Genome meta-analysis

Packages in R

Package Characteristics

Package	Version	Title	Effect Size	Power	Missing Data	Dependent Effects	Fixed Effect	Random Effects	Moderator Analyses	Publication Bias	Sensitivity Analysis	Creates Plots	Primary Function
General meta-analysis													
CAMAN	0.7	Finite mixture models and meta-analysis tools						✓	✓				bivariate
epiR	0.9-62	Tools for the analysis of epidemiological data	✓		✓		✓	✓					epi.dsl
gmeta	2.2-3	Meta-analysis via a unified framework under confidence distribution	✓			✓	✓	✓				✓	gmeta
Mac	1.1	Meta-analysis with correlations	✓		✓	✓	✓	✓	✓	✓	✓	✓	mareg
Mad	0.8-2	Meta-analysis with mean differences	✓		✓	✓	✓	✓	✓	✓		✓	mareg
Meta	4.2-0	General package for meta-analysis	✓		✓		✓	✓	✓	✓	✓	✓	metacont
metacor	1.0-2	Meta-analysis of correlation coefficients	✓				✓	✓					metacor.DSL
metafor	1.9-5	Meta-analysis package for R	✓		✓	✓	✓	✓	✓	✓	✓	✓	rma
metaplust	0.7-1	Robust meta-analysis and meta-regression	✓			✓		✓	✓		✓	✓	metaplust
psychometric	2.2	Applied psychometric theory					✓		✓	✓		✓	MetaTable
rmeta	2.16	Meta-analysis	✓				✓	✓		✓	✓	✓	meta.MH

Main functions in meta packages



(Harrer et al., 2021)

References

- Borenstein, M., Hedges, L. V., Higgins, J. P. T. & Rothstein, H. R. A basic introduction to fixed-effect and random-effects models for meta-analysis. *Res. Synth. Methods* 1, 97–111 (2010).
- Harrer, M., Cuijpers, P., Furukawa, T.A., & Ebert, D.D. (2021). [Doing Meta-Analysis with R: A Hands-On Guide](#). Boca Raton, FL and London: Chapman & Hall/CRC Press. ISBN 978-0-367-61007-4.
- Polanin, J. R., Hennessy, E. A. & Tanner-Smith, E. E. A Review of Meta-Analysis Packages in R. *J. Educ. Behav. Stat.* 42, 206–242 (2017).
- Rücker, G., Schwarzer, G., Carpenter, J. R. & Schumacher, M. Undue reliance on I² in assessing heterogeneity may mislead. *BMC Med. Res. Methodol.* 8, 1–9 (2008).

Hands-on in



Thank you!



tengkuhanismokhtar@gmail.com
<https://tengkuhanis.netlify.app/>