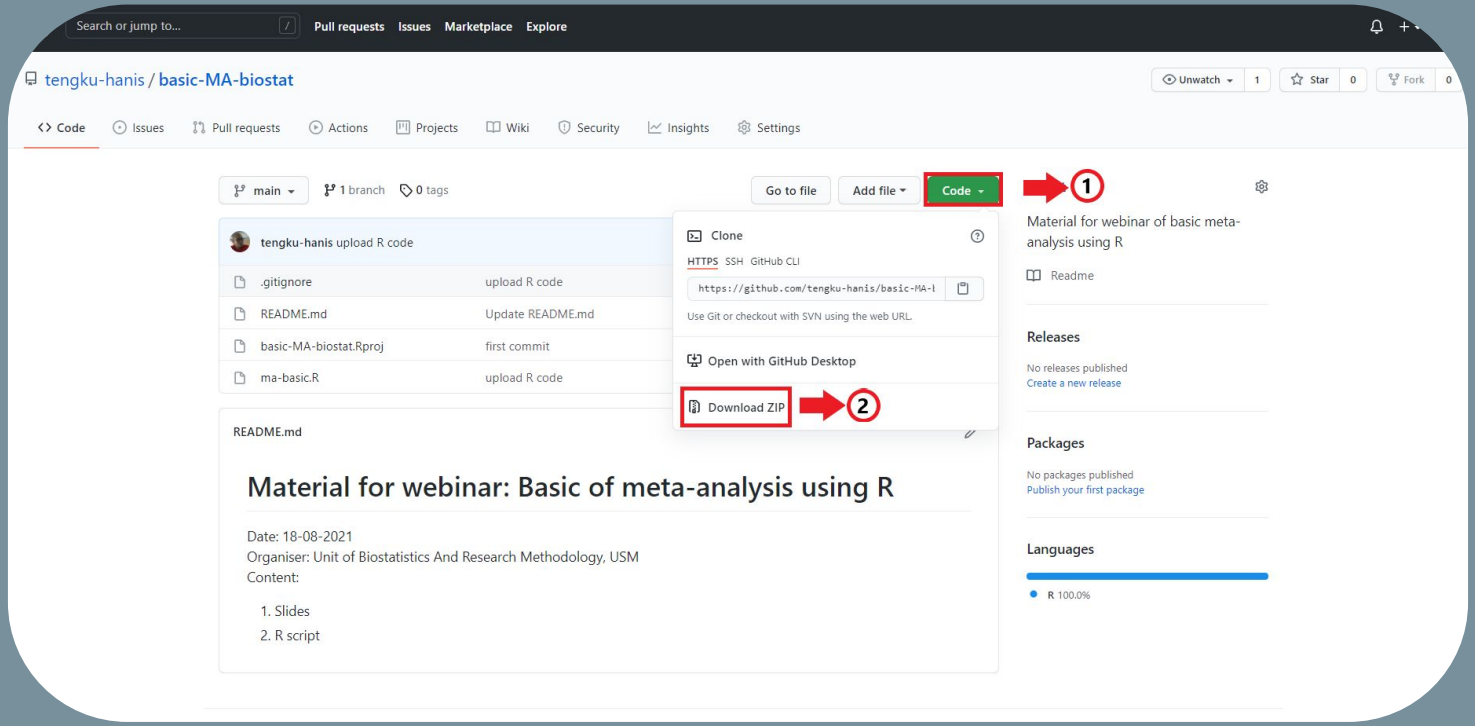
Basic of meta-analysis using R

Tengku Muhd Hanis Mokhtar
PhD student, USM
August 18, 2021

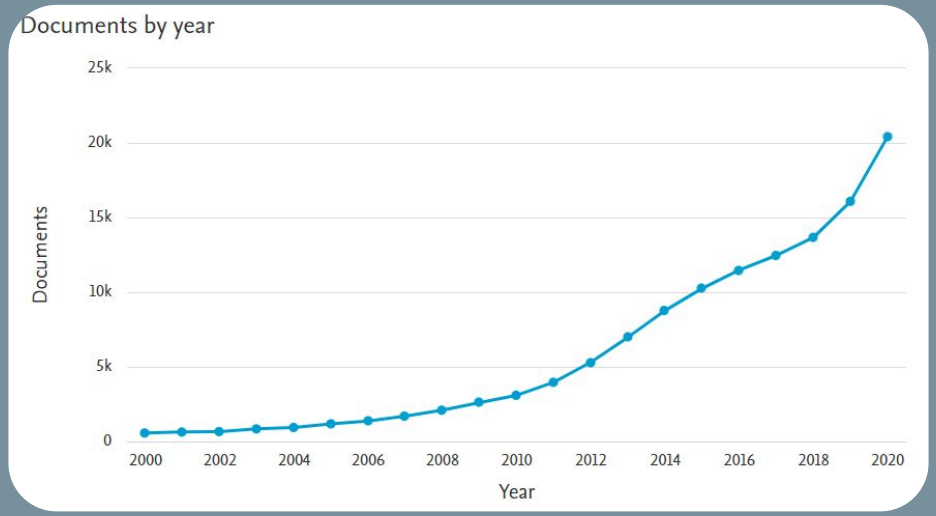
Download material

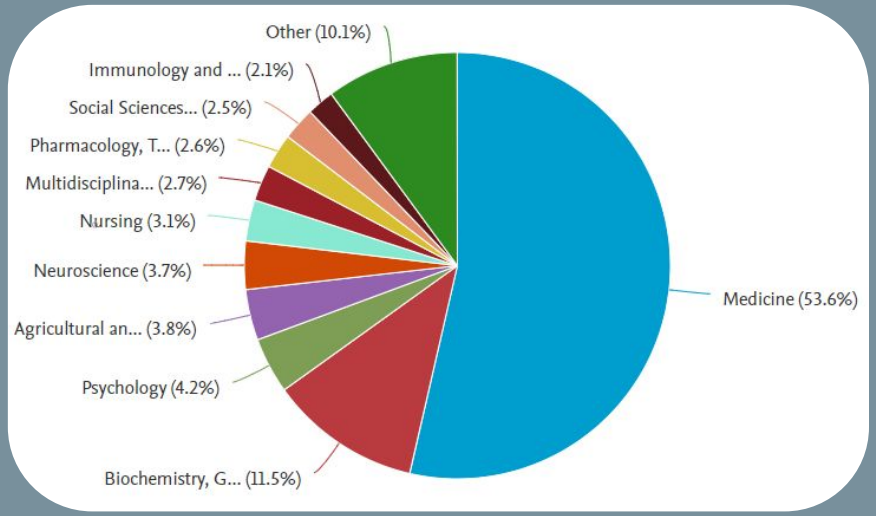
https://github.com/tengku-hanis/webinar-basic-MA



Background

- Meta-analysis:
  - Statistical methods used to combine individual results into pooled result
- From Scopus database (13-08-2021): 146, 762 documents





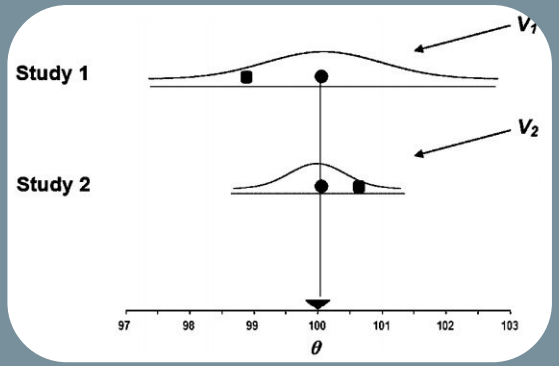
Basic jargons

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

Basic jargons (cont.)

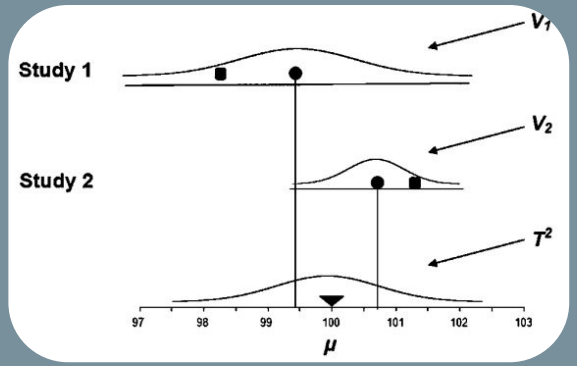
1) Fixed effect:

- 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.)

2) 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 at al., 2008

3) Publication bias:

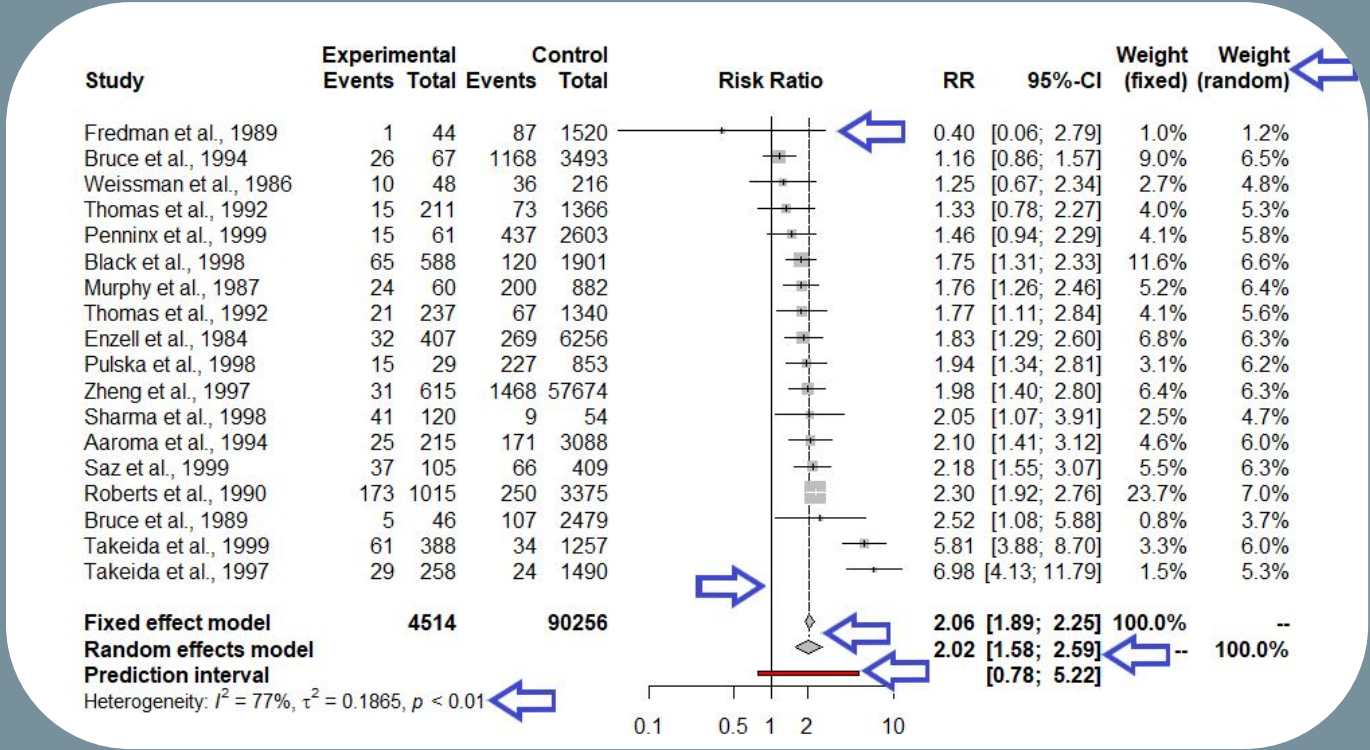
- Studies being published depends on the its result
- Consequences:
  - Overestimate the effect size
  - Overlook negative effect size

Basic jargons (cont.)

- Certain publication bias caused by small study effect and p-hacking can be statistically adjusted (most causes usually unknown)
- 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

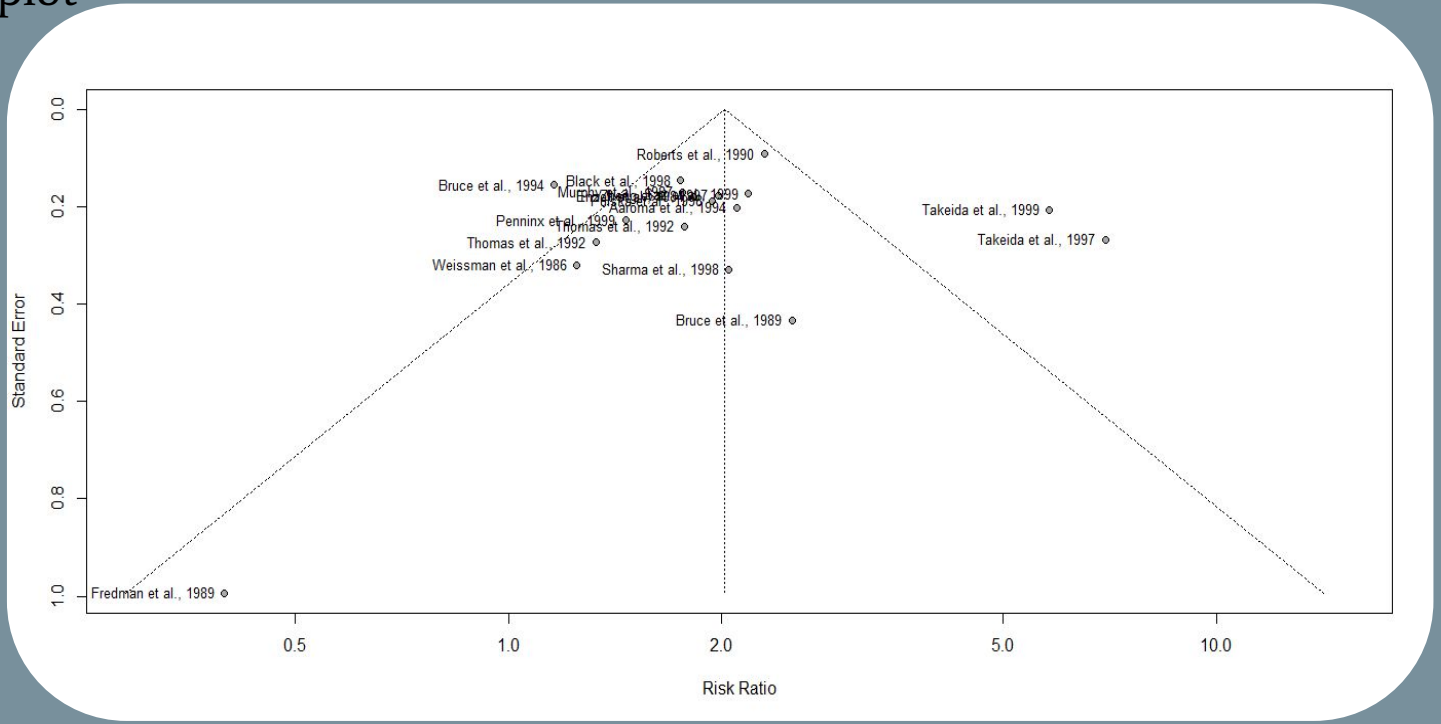
Basic jargons (cont.)

4) Forest plot

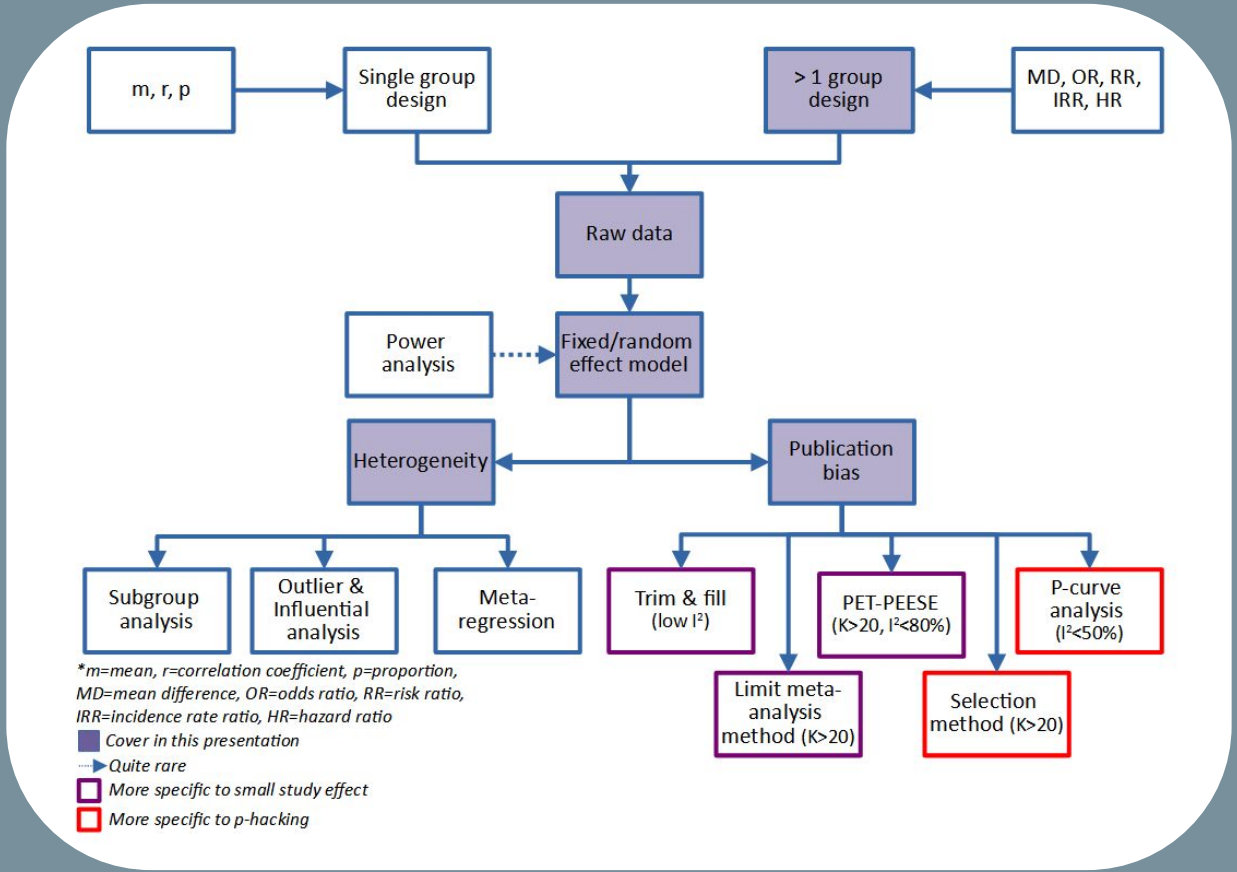


Basic jargons (cont.)

5) Funnel plot



General framework



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; $I^2 > 50\%$)
- Other publication bias related method
- GOSH (graphical display of study heterogeneity) analysis
- 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

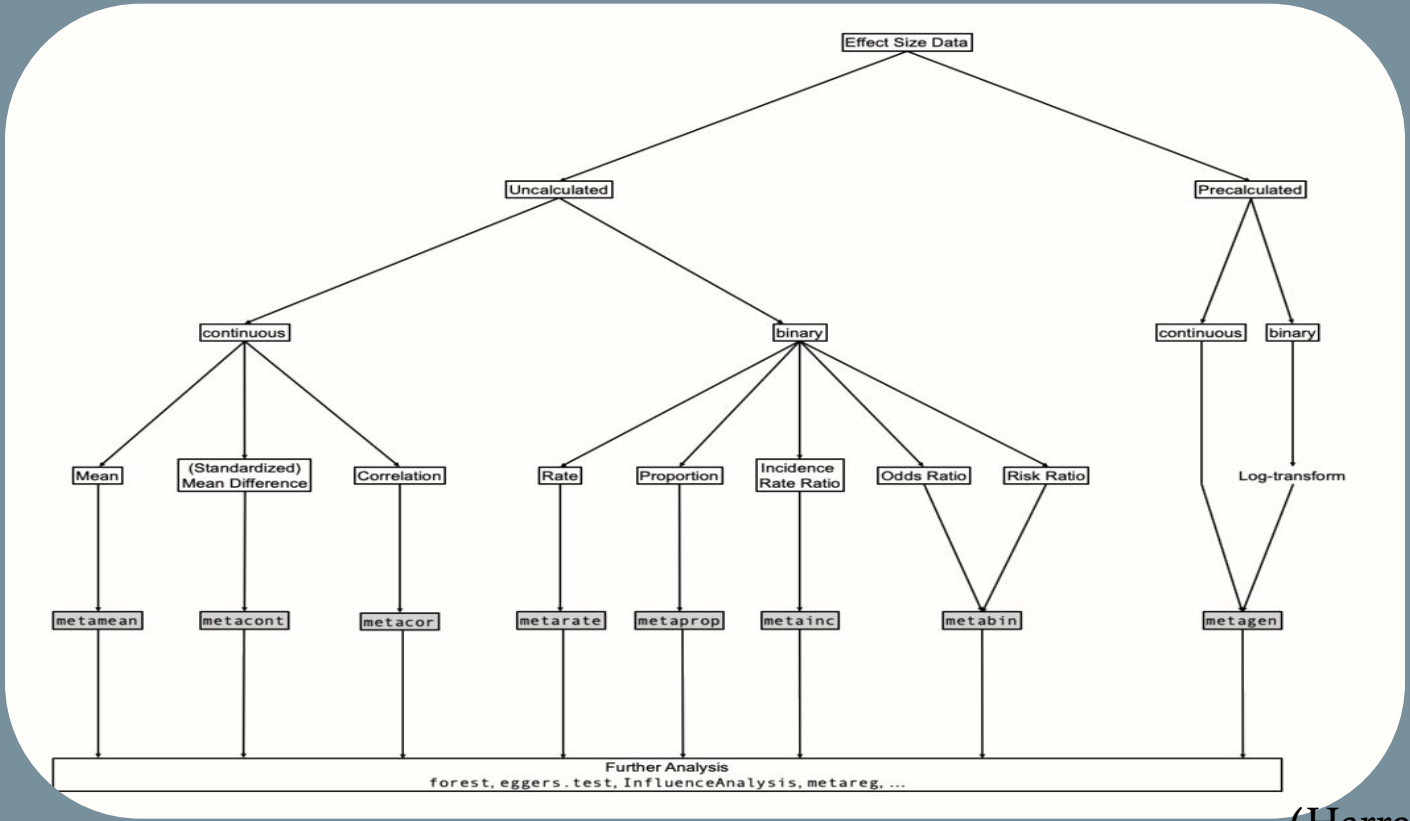
Packages in R (CRAN)

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
metaplus	0.7-1	Robust meta-analysis and meta-regression	√			√		√	√		√	√	metaplus
psychometric	2.2	Applied psychometric theory					√		√	√		√	MetaTable
rmeta	2.16	Meta-analysis	√				√	√		√	√	√	meta.MH

(Polanin et al., 2017)

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).
- Wolfgang Viechtbauer. (2021, February 8). The metafor package. Homepage [The metafor Package]. https://www.metafor-project.org/doku.php/metafor.

Question?

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

Hands-on in