An introduction to meta-analysis in R

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About me

Background:

- PhD student in Department of Community Medicine, USM
- MSc (Medical Statistics) from USM, 2019
- MBBCh from Al-Azhar University, 2015

Interest:

- Medical statistics; survival analysis, poisson regression, meta-analysis
- Machine learning application in medical sciences
- Text analysis, bibliometrics, scientometrics

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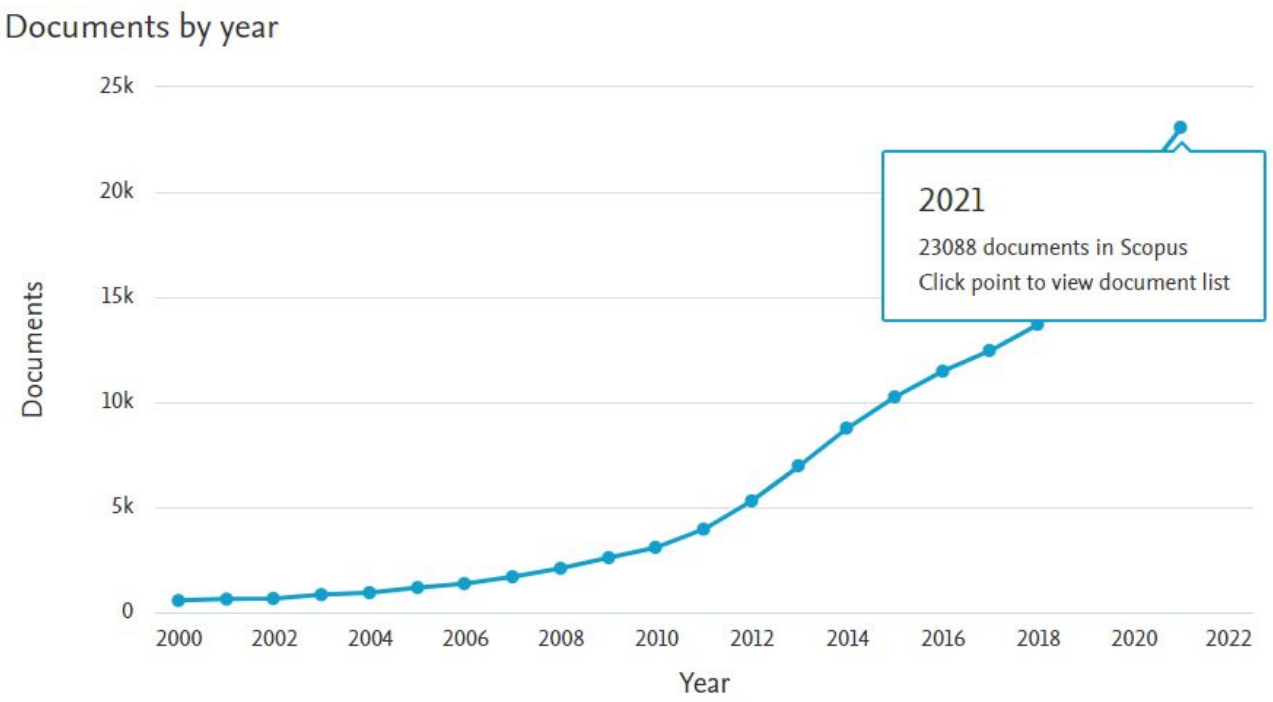
Download material: https://tny.im/eOXVV

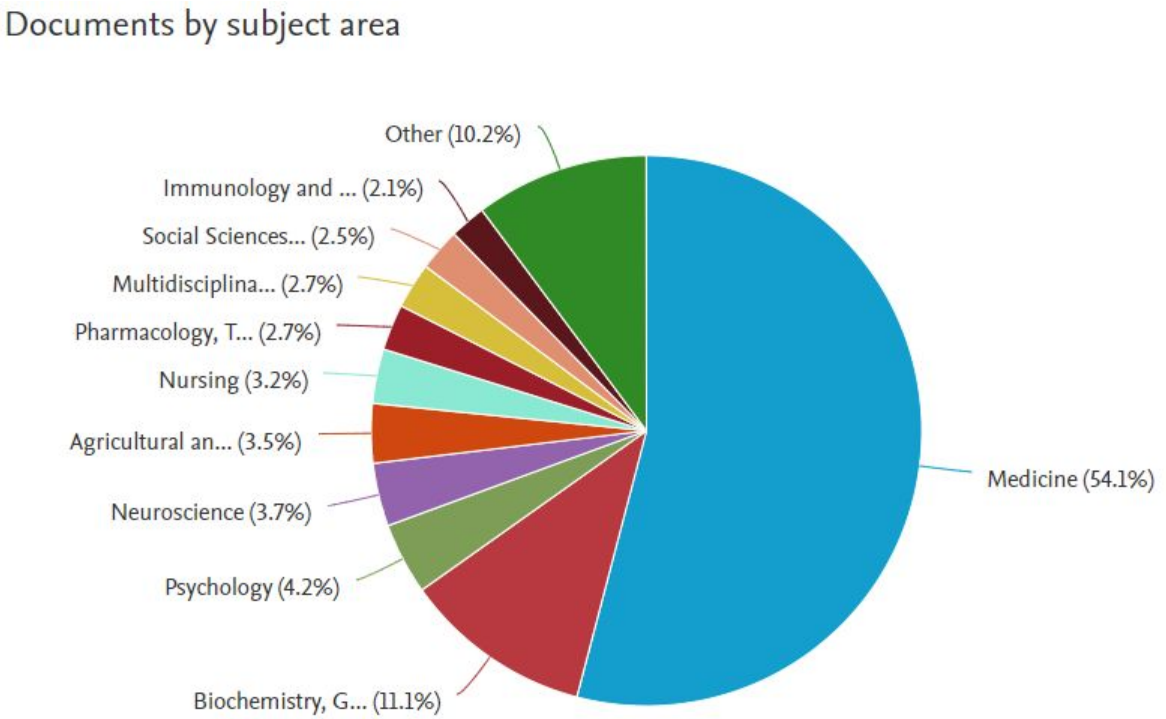
Things to note

- I'm going to assume everyone has **some familiarity with R**, but feel free to ask anything
- use **RStudio cloud**
- We are not going to cover everything related to meta-analysis
- Hopefully, by the end of this workshop:
  - Able to **understand** meta-analysis paper
  - Able to **grasp the flow and basic concept** in meta-analysis
  - Gain basic knowledge to **explore more**

Background

- Meta-analysis:
  - Statistical methods used to combine the results of several scientific studies into a pooled result
- From Scopus database (01-11-2021): 152, 352 meta-analysis papers





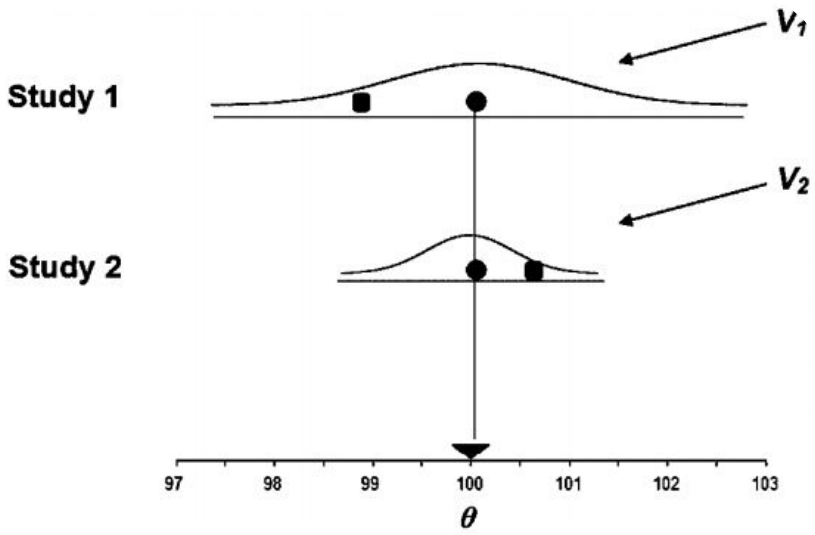
Jargons

- Fixed vs random effect model
- Heterogeneity
- Publication bias
- Forest plot
- Funnel plot

Jargons (cont.)

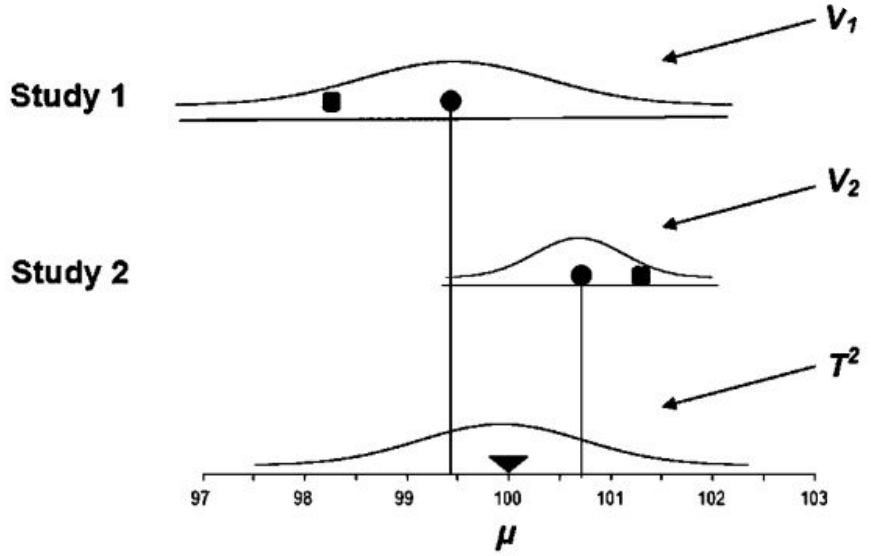
Fixed/common effect model:

- One true effect size
- Estimate one true effect size



Random effect model:

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



(Borenstein et al., 2010)

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 at al., 2008

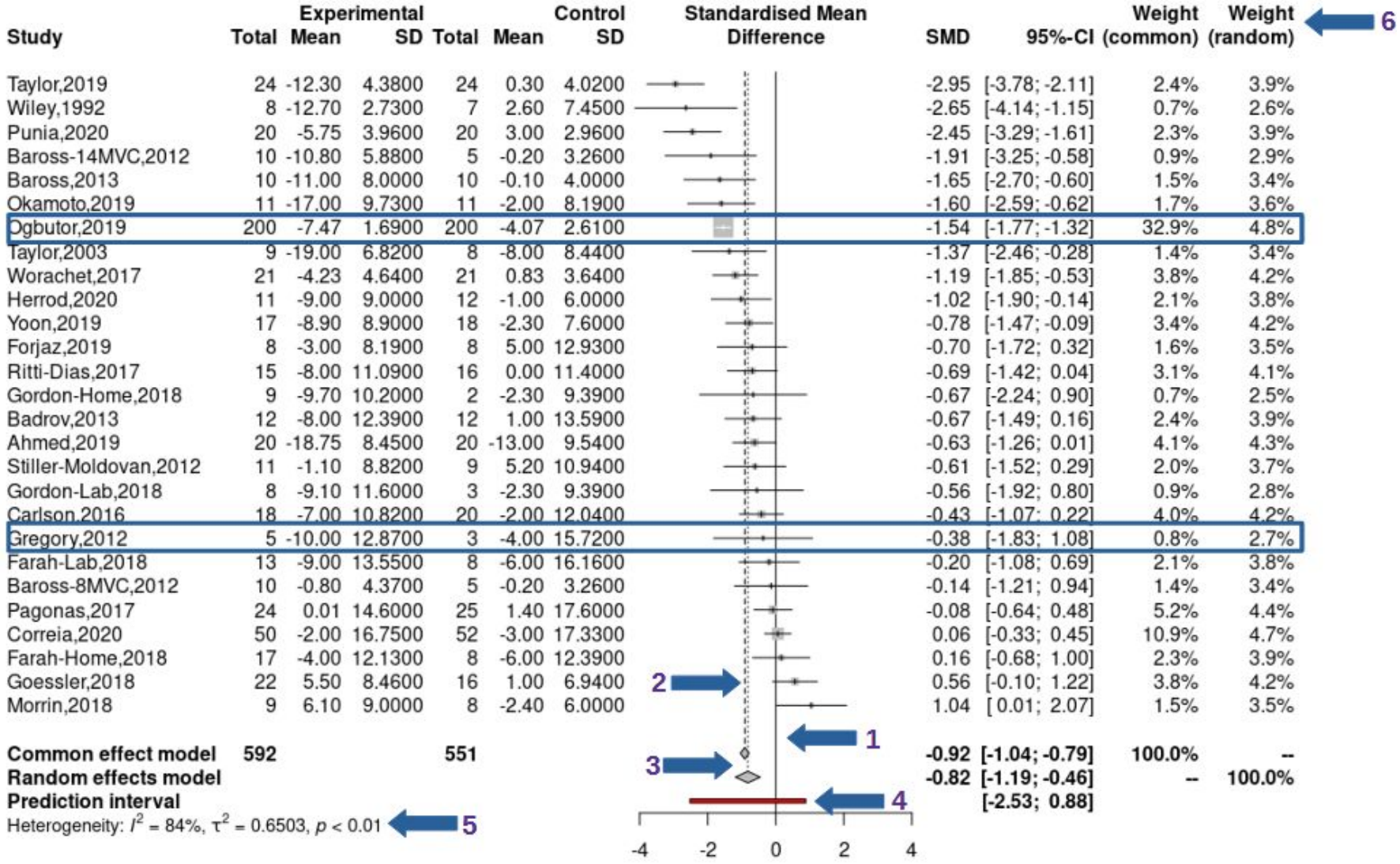
- Publication bias:
  - Studies being published depends on the its result
  - Consequences:
    - Overestimate the effect size
    - Overlook negative effect size

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

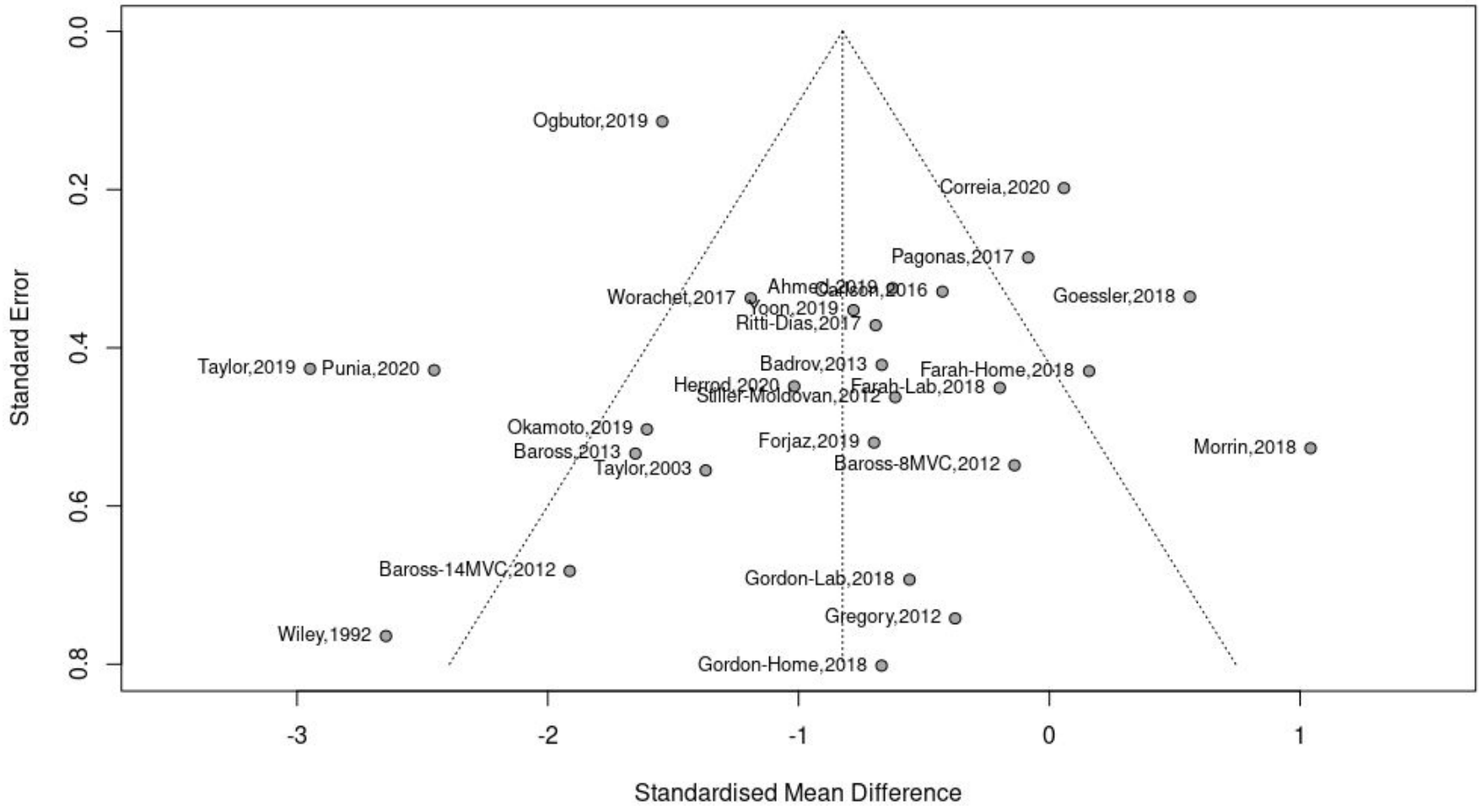
Jargons (cont.)

- Forest plot

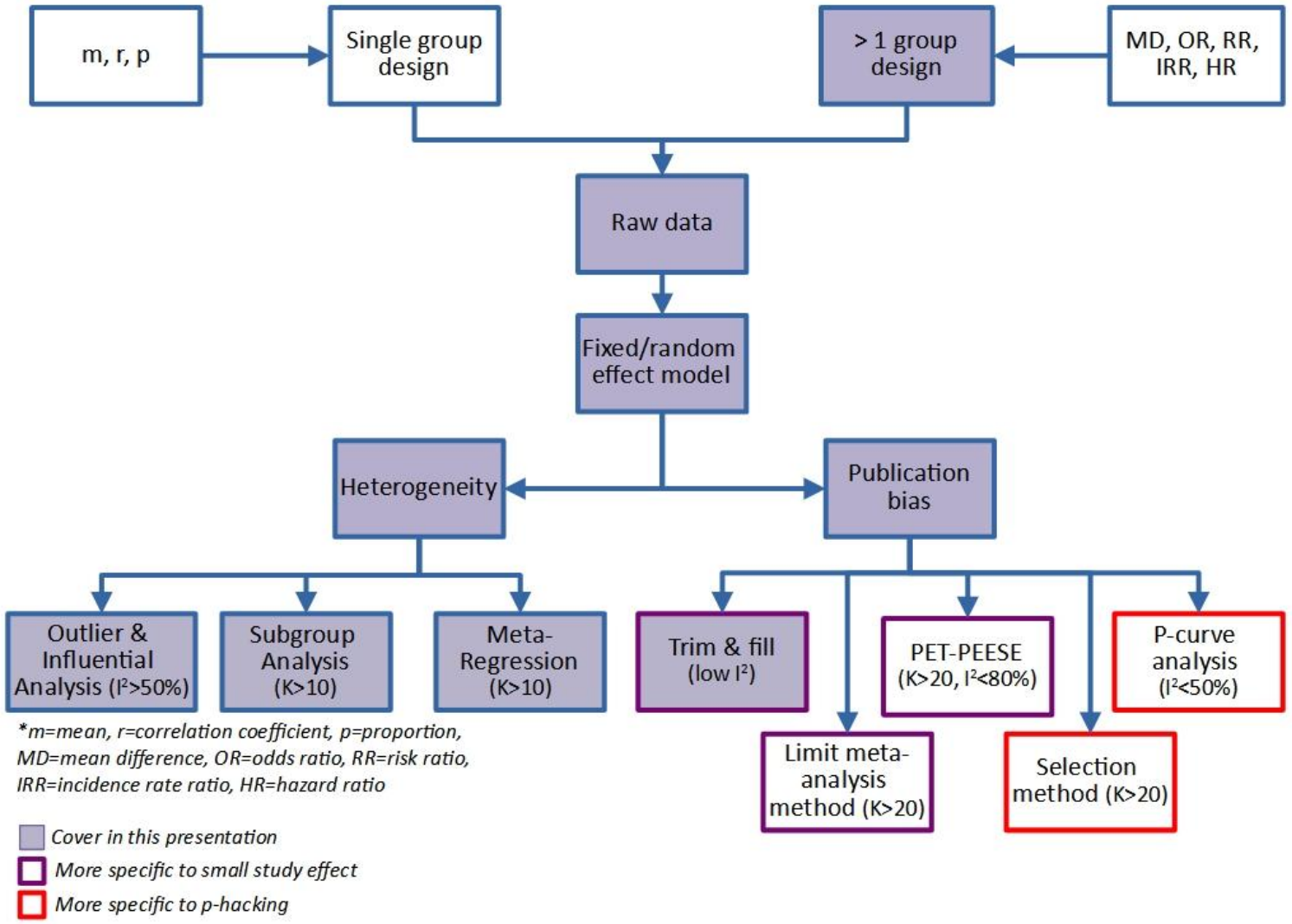


Jargons (cont.)

- Funnel plot



General framework



Type of meta-analysis

- **“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
- "Multilevel" meta-analysis
  - There is 3rd level
- Network meta-analysis
  - Compare several treatment effect directly and indirectly
- Dose response meta-analysis
  - Quantify level of exposure effect to response

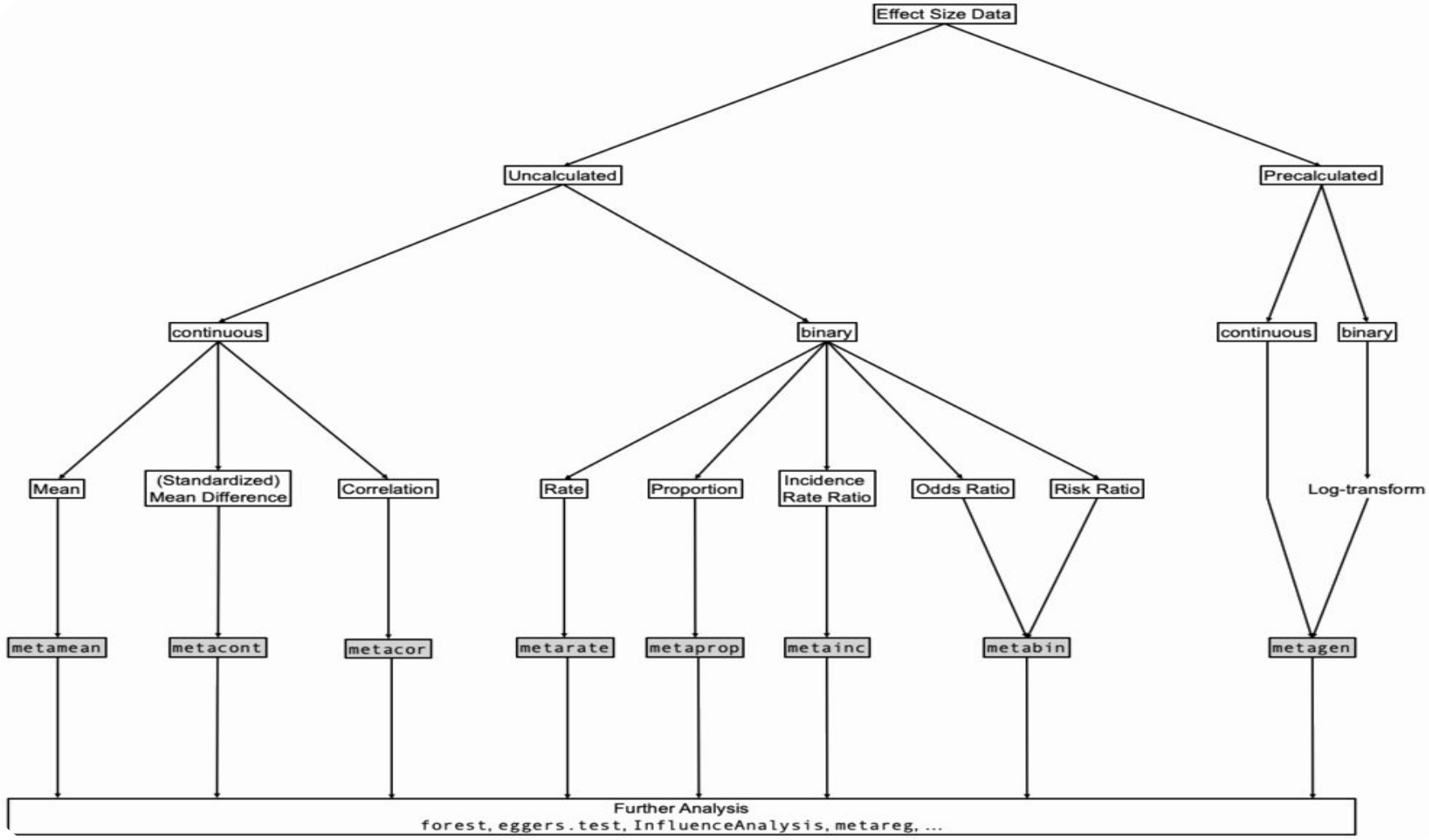
Type of meta-analysis (cont.)

- Diagnostic test accuracy meta-analysis
  - Pool sensitivity, specificity, AUC
- Multivariate/Anova/SEM meta-analysis
- Bayesian approach
- Genome meta-analysis

R packages for meta-analysis

- Main packages:
  - **meta**
  - metafor
- Other packages on CRAN (a lot !)
- Unofficial packages (in GitHub, etc):
  - **dmetar**
  - dmetatools
  - etc

Main functions in meta package



(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.
- 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).

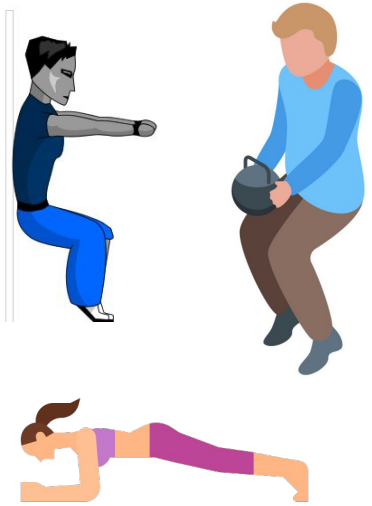
Question?

About data

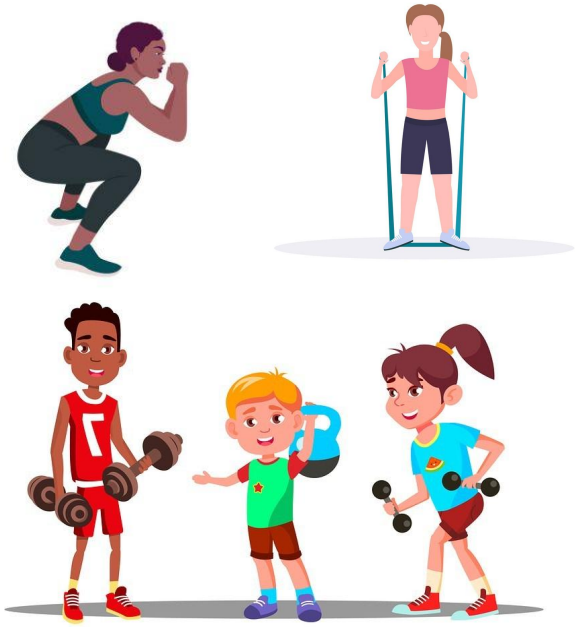
- Our aim - to assess the effectiveness of isometric resistance training (IRT) in reducing systolic blood pressure among hypertensive individuals
- Data:
  - Treatment - IRT regiment
  - Control - aerobic exercise, dynamic RT and non-exercise control (be physically active, etc)
- Study criterias:
  - Participants:
    - High-normal (SBP 130–139 mmHg or DBP 85–89 mmHg)
    - Grade 1 hypertension (SBP 140–159 mmHg or DBP 90–99 mmHg)
    - Grade 2 hypertension (SBP ≥160 mmHg or DBP ≥100 mmHg)
  - IRT - must be 3 weeks duration

About data (cont.)

- Resistance training - any exercise that causes muscle to contract against an external resistance



Isometric RT - involve muscle contraction without any movement of the surrounding joints



Dynamic RT - involves joint movement (imagine the pictures move)

Hands-on in R