This vignette provides up-to-date commands for the analyses in “How to perform a meta-analysis with R: a practical tutorial”, *Evid Based Ment Health* (Balduzzi, Rücker, and Schwarzer 2019).

**Install R packages**

```r
install.packages(c("meta", "metasens"))
```

**Make R packages available**

```r
library(meta)
#> Loading required package: metadat
#> Loading 'meta' package (version 7.0-0).
#> Type 'help(meta)' for a brief overview.
#> Readers of 'Meta-Analysis with R (Use R!)' should install
#> older version of 'meta' package: https://tinyurl.com/dt4y5drs
library(metasens)
```

Note, a similar message would be printed for R package `metasens`. However, this vignette does not actually load `metasens` as it might not be installed in addition to `meta`.

**Default settings for R session**

Print results with two significant digits and use Paule-Mandel estimator for between-study variance.

```r
settings.meta(digits = 2, method.tau = "PM")
```

Note, in the publication, argument ‘method.tau’ was used in R function `metabin()`. Here, we set the Paule-Mandel method as the default for any meta-analysis conducted in the current R session.

**Import the dataset**

```r
joy = read.csv("Joy2006.txt")
# Add new variable: miss
joy$miss = ifelse( (joy$drop.h + joy$drop.p) == 0, 
                   "Without missing data", "With missing data")
head(joy)
#> author year  resp.h fail.h  drop.h resp.p fail.p drop.p miss
#> 1 Arvanitis 1997 25 25 2 18 33 0 With missing data
#> 2 Beasley 1996 29 18 22 20 14 34 With missing data
#> 3 Bechelli 1983 12 17 1 2 28 1 With missing data
#> 4 Borison 1992 3 9 0 0 12 0 Without missing data
#> 5 Chouinard 1993 10 11 0 3 19 0 Without missing data
#> 6 Durost 1964 11 8 0 1 14 0 Without missing data
```
Section ‘Fixed effect and random effects meta-analysis’

```r
m.publ = metabin(resp.h, resp.h + fail.h, resp.p, resp.p + fail.p,
data = joy, studlab = paste0(author, " (", year, ")"),
label.e = "Haloperidol", label.c = "Placebo",
label.left = "Favours placebo", label.right = "Favours haloperidol")

summary(m.publ)
```

Print results of meta-analysis (Figure 1).

<table>
<thead>
<tr>
<th></th>
<th>RR</th>
<th>95%-CI</th>
<th>%W(common)</th>
<th>%W(random)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arvanitis (1997)</td>
<td>1.42</td>
<td>[0.89; 2.25]</td>
<td>21.1</td>
<td>14.1</td>
</tr>
<tr>
<td>Beasley (1996)</td>
<td>1.05</td>
<td>[0.73; 1.50]</td>
<td>27.5</td>
<td>15.6</td>
</tr>
<tr>
<td>Bechelli (1983)</td>
<td>6.21</td>
<td>[1.52; 25.35]</td>
<td>2.3</td>
<td>4.7</td>
</tr>
<tr>
<td>Borison (1992)</td>
<td>7.00</td>
<td>[0.40; 121.94]</td>
<td>0.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Chouinard (1993)</td>
<td>3.49</td>
<td>[1.11; 10.95]</td>
<td>3.5</td>
<td>6.3</td>
</tr>
<tr>
<td>Durost (1964)</td>
<td>8.68</td>
<td>[1.26; 59.95]</td>
<td>1.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Garry (1962)</td>
<td>1.75</td>
<td>[0.58; 5.24]</td>
<td>4.7</td>
<td>6.7</td>
</tr>
<tr>
<td>Howard (1974)</td>
<td>2.04</td>
<td>[0.67; 6.21]</td>
<td>4.0</td>
<td>6.6</td>
</tr>
<tr>
<td>Marder (1994)</td>
<td>1.36</td>
<td>[0.75; 2.47]</td>
<td>16.6</td>
<td>12.2</td>
</tr>
<tr>
<td>Nishikawa (1982)</td>
<td>3.00</td>
<td>[0.14; 65.55]</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Nishikawa (1984)</td>
<td>9.00</td>
<td>[0.57; 142.29]</td>
<td>0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Reschke (1974)</td>
<td>3.79</td>
<td>[1.06; 13.60]</td>
<td>3.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Selman (1976)</td>
<td>1.48</td>
<td>[0.94; 2.35]</td>
<td>10.3</td>
<td>14.1</td>
</tr>
<tr>
<td>Serafetinides (1972)</td>
<td>8.38</td>
<td>[0.50; 141.44]</td>
<td>0.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Simpson (1967)</td>
<td>2.27</td>
<td>[0.12; 41.77]</td>
<td>0.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Spencer (1992)</td>
<td>11.00</td>
<td>[1.67; 72.40]</td>
<td>1.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Vichaiya (1971)</td>
<td>19.00</td>
<td>[1.16; 311.71]</td>
<td>0.6</td>
<td>1.5</td>
</tr>
</tbody>
</table>

# Number of studies: k = 17
# Number of observations: o = 818 (o.e = 446, o.c = 372)
# Number of events: e = 274
```
Test of heterogeneity:

<table>
<thead>
<tr>
<th></th>
<th>Q d.f.</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>27.24</td>
<td>16</td>
<td>0.0388</td>
</tr>
</tbody>
</table>

Details on meta-analytical method:
- Mantel-Haenszel method (common effect model)
- Inverse variance method (random effects model)
- Paule-Mandel estimator for \( \tau^2 \)
- Q-Profile method for confidence interval of \( \tau^2 \) and \( \tau \)
- Continuity correction of 0.5 in studies with zero cell frequencies

Same printout (result not shown)

```
print(summary(m.publ))
```

Create Figure 2 (file ‘figure2.pdf’).

```
forest(m.publ, sortvar = year, prediction = TRUE, file = "figure2.pdf", width = 10)
```

<table>
<thead>
<tr>
<th>Study</th>
<th>Events</th>
<th>Placebo</th>
<th>Event</th>
<th>Placebo</th>
<th>Risk Ratio</th>
<th>95%-CI</th>
<th>RR 95%-CI (common)</th>
<th>Weight (common)</th>
<th>Weight (random)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garry (1962)</td>
<td>7</td>
<td>25</td>
<td>4</td>
<td>25</td>
<td>1.75</td>
<td>[1.59; 2.50]</td>
<td>4.7%</td>
<td>6.7%</td>
<td></td>
</tr>
<tr>
<td>Durost (1964)</td>
<td>11</td>
<td>19</td>
<td>1</td>
<td>15</td>
<td>8.68</td>
<td>[1.26; 59.95]</td>
<td>1.3%</td>
<td>2.8%</td>
<td></td>
</tr>
<tr>
<td>Simpson (1967)</td>
<td>2</td>
<td>16</td>
<td>0</td>
<td>7</td>
<td>2.27</td>
<td>[0.12; 41.77]</td>
<td>0.8%</td>
<td>1.4%</td>
<td></td>
</tr>
<tr>
<td>Vichaiya (1971)</td>
<td>9</td>
<td>29</td>
<td>0</td>
<td>29</td>
<td>19.00</td>
<td>[1.16; 311.71]</td>
<td>0.6%</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<td>Serafetinides (1972)</td>
<td>4</td>
<td>14</td>
<td>0</td>
<td>13</td>
<td>8.38</td>
<td>[0.50; 141.44]</td>
<td>0.6%</td>
<td>1.4%</td>
<td></td>
</tr>
<tr>
<td>Howard (1974)</td>
<td>8</td>
<td>17</td>
<td>3</td>
<td>13</td>
<td>2.04</td>
<td>[0.67; 6.21]</td>
<td>4.0%</td>
<td>6.6%</td>
<td></td>
</tr>
<tr>
<td>Reschke (1974)</td>
<td>20</td>
<td>29</td>
<td>2</td>
<td>11</td>
<td>3.79</td>
<td>[1.06; 13.60]</td>
<td>3.4%</td>
<td>5.4%</td>
<td></td>
</tr>
<tr>
<td>Selman (1976)</td>
<td>17</td>
<td>18</td>
<td>7</td>
<td>11</td>
<td>1.48</td>
<td>[0.94; 2.35]</td>
<td>10.3%</td>
<td>14.1%</td>
<td></td>
</tr>
<tr>
<td>Nishikawa (1982)</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>3.00</td>
<td>[0.14; 65.55]</td>
<td>0.6%</td>
<td>1.2%</td>
<td></td>
</tr>
<tr>
<td>Bechelli (1983)</td>
<td>12</td>
<td>29</td>
<td>2</td>
<td>30</td>
<td>6.21</td>
<td>[1.52; 25.35]</td>
<td>2.3%</td>
<td>4.7%</td>
<td></td>
</tr>
<tr>
<td>Nishikawa (1984)</td>
<td>11</td>
<td>34</td>
<td>0</td>
<td>13</td>
<td>9.00</td>
<td>[0.57; 142.29]</td>
<td>0.8%</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<td>Borison (1992)</td>
<td>3</td>
<td>12</td>
<td>0</td>
<td>12</td>
<td>7.00</td>
<td>[0.40; 121.94]</td>
<td>0.6%</td>
<td>1.4%</td>
<td></td>
</tr>
<tr>
<td>Spencer (1992)</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>12</td>
<td>11.00</td>
<td>[1.67; 72.40]</td>
<td>1.2%</td>
<td>3.0%</td>
<td></td>
</tr>
<tr>
<td>Chouvard (1993)</td>
<td>10</td>
<td>21</td>
<td>3</td>
<td>22</td>
<td>3.49</td>
<td>[1.11; 10.94]</td>
<td>3.5%</td>
<td>6.3%</td>
<td></td>
</tr>
<tr>
<td>Marder (1994)</td>
<td>19</td>
<td>64</td>
<td>14</td>
<td>64</td>
<td>1.36</td>
<td>[0.75; 2.47]</td>
<td>16.6%</td>
<td>12.2%</td>
<td></td>
</tr>
<tr>
<td>Beasley (1996)</td>
<td>29</td>
<td>47</td>
<td>20</td>
<td>34</td>
<td>1.05</td>
<td>[0.73; 1.50]</td>
<td>27.5%</td>
<td>15.6%</td>
<td></td>
</tr>
<tr>
<td>Arvanitis (1997)</td>
<td>25</td>
<td>50</td>
<td>18</td>
<td>51</td>
<td>1.42</td>
<td>[0.89; 2.25]</td>
<td>21.1%</td>
<td>14.1%</td>
<td></td>
</tr>
</tbody>
</table>

Common effect model: 446 372

Random effects model: 2.09 [1.69; 2.59] 6.71 < 0.0001

Prediction interval: [0.81; 5.67]

Section ‘Assessing the impact of missing outcome data’

Subgroup analysis of studies with and without missing data

```
m.publ.sub = update(m.publ, subgroup = miss, print.subgroup.name = FALSE)
m.publ.sub
```

<table>
<thead>
<tr>
<th>RR 95%-CI</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.09 [1.69; 2.59]</td>
<td>6.71</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>2.15 [1.51; 3.06]</td>
<td>4.23</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>
Quantifying heterogeneity:
\[ \hat{\tau}^2 = 0.1754 \ [0.0000; 1.0088]; \tau = 0.4188 \ [0.0000; 1.0044] \]
\[ I^2 = 41.3\% \ [0.0\%; 67.0\%]; H = 1.30 \ [1.00; 1.74] \]

Test of heterogeneity:
\[ Q \ d.f. \ p-value \]
\[ 27.24 \ 16 \ 0.0388 \]

Results for subgroups (common effect model):

<table>
<thead>
<tr>
<th>k</th>
<th>RR</th>
<th>95%-CI</th>
<th>Q</th>
<th>I^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>With missing data</td>
<td>10</td>
<td>1.70 [1.35; 2.14]</td>
<td>13.73</td>
<td>34.4%</td>
</tr>
<tr>
<td>Without missing data</td>
<td>7</td>
<td>4.36 [2.45; 7.77]</td>
<td>3.35</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Test for subgroup differences (common effect model):
\[ Q \ d.f. \ p-value \]
\[ Between \ groups \ 8.82 \ 1 \ 0.0030 \]

Results for subgroups (random effects model):

<table>
<thead>
<tr>
<th>k</th>
<th>RR</th>
<th>95%-CI</th>
<th>\hat{\tau}^2</th>
<th>\tau</th>
</tr>
</thead>
<tbody>
<tr>
<td>With missing data</td>
<td>10</td>
<td>1.71 [1.13; 2.59]</td>
<td>0.1785</td>
<td>0.4224</td>
</tr>
<tr>
<td>Without missing data</td>
<td>7</td>
<td>3.80 [2.13; 6.80]</td>
<td>0.0</td>
<td>0</td>
</tr>
</tbody>
</table>

Test for subgroup differences (random effects model):
\[ Q \ d.f. \ p-value \]
\[ Between \ groups \ 4.80 \ 1 \ 0.0285 \]

Details on meta-analytical method:
- Mantel-Haenszel method (common effect model)
- Inverse variance method (random effects model)
- Paule-Mandel estimator for \hat{\tau}^2
- Q-Profile method for confidence interval of \hat{\tau}^2 and \tau
- Continuity correction of 0.5 in studies with zero cell frequencies

Create Figure 3 (file 'figure3.pdf').

```r
forest(m.publ.sub, sortvar = year,
\quad xlim = c(0.1, 100), at = c(0.1, 0.3, 1, 3, 10, 30, 100),
\quad test.subgroup.common = FALSE,
\quad label.test.subgroup.random = "Test for subgroup differences:",
\quad file = "figure3.pdf", width = 10)
```
<table>
<thead>
<tr>
<th>Study</th>
<th>Haloperidol</th>
<th>Placebo</th>
<th>Risk Ratio</th>
<th>RR</th>
<th>95%−CI</th>
<th>Weight (common)</th>
<th>Weight (random)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Events Total</td>
<td>Events Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With missing data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garry (1962)</td>
<td>7</td>
<td>25</td>
<td>4</td>
<td>25</td>
<td></td>
<td>1.75 [0.58; 5.24]</td>
<td>4.7%</td>
</tr>
<tr>
<td>Simpson (1967)</td>
<td>2</td>
<td>16</td>
<td>0</td>
<td>7</td>
<td></td>
<td>2.27 [0.12; 41.77]</td>
<td>0.8%</td>
</tr>
<tr>
<td>Vichaiya (1971)</td>
<td>9</td>
<td>29</td>
<td>0</td>
<td>29</td>
<td></td>
<td>13.00 [1.16; 311.71]</td>
<td>0.6%</td>
</tr>
<tr>
<td>Serafetinides (1972)</td>
<td>4</td>
<td>14</td>
<td>0</td>
<td>13</td>
<td></td>
<td>8.38 [0.50; 141.44]</td>
<td>0.6%</td>
</tr>
<tr>
<td>Selman (1976)</td>
<td>17</td>
<td>18</td>
<td>7</td>
<td>11</td>
<td></td>
<td>1.48 [0.94; 2.35]</td>
<td>10.3%</td>
</tr>
<tr>
<td>Bechelli (1983)</td>
<td>12</td>
<td>29</td>
<td>2</td>
<td>30</td>
<td></td>
<td>6.21 [1.52; 25.35]</td>
<td>2.3%</td>
</tr>
<tr>
<td>Nishikawa (1984)</td>
<td>11</td>
<td>34</td>
<td>0</td>
<td>13</td>
<td></td>
<td>9.00 [0.57; 142.29]</td>
<td>0.8%</td>
</tr>
<tr>
<td>Marder (1994)</td>
<td>19</td>
<td>64</td>
<td>14</td>
<td>64</td>
<td></td>
<td>1.36 [0.75; 2.47]</td>
<td>18.6%</td>
</tr>
<tr>
<td>Beasley (1996)</td>
<td>29</td>
<td>47</td>
<td>20</td>
<td>34</td>
<td></td>
<td>1.05 [0.73; 1.50]</td>
<td>27.5%</td>
</tr>
<tr>
<td>Arvanitis (1997)</td>
<td>25</td>
<td>50</td>
<td>18</td>
<td>51</td>
<td></td>
<td>1.42 [0.89; 2.25]</td>
<td>21.1%</td>
</tr>
<tr>
<td>Common effect model</td>
<td>326</td>
<td>277</td>
<td></td>
<td></td>
<td></td>
<td>1.70 [1.35; 2.14]</td>
<td>85.4%</td>
</tr>
<tr>
<td>Random effects model</td>
<td>1.71</td>
<td>[1.13; 2.59]</td>
<td>—</td>
<td>73.2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: $I^2 = 34%$, $\tau^2 = 0.1785$, $p = 0.13$</td>
<td></td>
<td></td>
<td>4.80</td>
<td>df = 1 ($p = 0.03$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without missing data</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durost (1964)</td>
<td>11</td>
<td>19</td>
<td>1</td>
<td>15</td>
<td></td>
<td>8.68 [1.26; 59.95]</td>
<td>1.3%</td>
</tr>
<tr>
<td>Howard (1974)</td>
<td>8</td>
<td>17</td>
<td>3</td>
<td>13</td>
<td></td>
<td>2.04 [0.67; 6.21]</td>
<td>4.0%</td>
</tr>
<tr>
<td>Reschke (1974)</td>
<td>20</td>
<td>29</td>
<td>2</td>
<td>11</td>
<td></td>
<td>3.79 [1.06; 13.60]</td>
<td>3.4%</td>
</tr>
<tr>
<td>Nishikawa (1982)</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td></td>
<td>3.00 [0.14; 65.55]</td>
<td>0.6%</td>
</tr>
<tr>
<td>Borison (1992)</td>
<td>3</td>
<td>12</td>
<td>0</td>
<td>12</td>
<td></td>
<td>7.00 [0.40; 121.94]</td>
<td>0.6%</td>
</tr>
<tr>
<td>Spencer (1992)</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>12</td>
<td></td>
<td>11.00 [1.67; 72.40]</td>
<td>1.2%</td>
</tr>
<tr>
<td>Chouinard (1993)</td>
<td>10</td>
<td>21</td>
<td>3</td>
<td>22</td>
<td></td>
<td>3.49 [1.11; 10.95]</td>
<td>3.5%</td>
</tr>
<tr>
<td>Common effect model</td>
<td>120</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td>4.36 [2.45; 7.77]</td>
<td>14.8%</td>
</tr>
<tr>
<td>Random effects model</td>
<td>3.80</td>
<td>[2.13; 6.60]</td>
<td>—</td>
<td>26.8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: $I^2 = 0%$, $\tau^2 = 0$, $p = 0.76$</td>
<td></td>
<td></td>
<td>4.80</td>
<td>df = 1 ($p = 0.03$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common effect model</td>
<td>446</td>
<td>372</td>
<td></td>
<td></td>
<td></td>
<td>2.09 [1.69; 2.59]</td>
<td>100.0%</td>
</tr>
<tr>
<td>Random effects model</td>
<td>2.15</td>
<td>[1.51; 3.06]</td>
<td>—</td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: $F = 41%$, $\tau^2 = 0.1754$, $p = 0.04$</td>
<td></td>
<td></td>
<td>4.80</td>
<td>df = 1 ($p = 0.03$)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test for subgroup differences: $\chi^2 = 4.80$, df = 1 ($p = 0.03$)

<table>
<thead>
<tr>
<th>Favours placebo</th>
<th>Favours haloperidol</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>100</td>
<td>−−</td>
</tr>
</tbody>
</table>

**Use imputation methods**

# Impute as no events (ICA-0) - default
mmiss.0 = metamiss(m.publ, drop.h, drop.p)

# Impute as events (ICA-1)
mmiss.1 = metamiss(m.publ, drop.h, drop.p, method = "1")

# Observed risk in control group (ICA-pc)
miss.pc = metamiss(m.publ, drop.h, drop.p, method = "pc")

# Observed risk in experimental group (ICA-pe)
miss.pe = metamiss(m.publ, drop.h, drop.p, method = "pe")

# Observed group-specific risks (ICA-p)
miss.p = metamiss(m.publ, drop.h, drop.p, method = "p")

# Best-case scenario (ICA-b)
miss.b = metamiss(m.publ, drop.h, drop.p, method = "b", small.values = "bad")

# Worst-case scenario (ICA-w)
miss.w = metamiss(m.publ, drop.h, drop.p, method = "w", small.values = "bad")

# Gamble-Hollis method
mmiss.gh = metamiss(m.publ, drop.h, drop.p, method = "GH")

# IMOR.e = 2 and IMOR.c = 2 (same as available case analysis)
miss.imor2 = metamiss(m.publ, drop.h, drop.p, method = "IMOR", IMOR.e = 2)

# IMOR.e = 0.5 and IMOR.c = 0.5
mmiss.imor0.5 = metamiss(m.publ, drop.h, drop.p, method = "IMOR", IMOR.e = 0.5)

Summarise results using R function metabind().

5
meths = c("Available case analysis (ACA)",
"Impute no events (ICA-0)", "Impute events (ICA-1)",
"Observed risk in control group (ICA-pc)",
"Observed risk in experimental group (ICA-pe)",
"Observed group-specific risks (ICA-p)",
"Best-case scenario (ICA-b)", "Worst-case scenario (ICA-w)",
"Gamble-Hollis analysis",
"IMOR.e = 2, IMOR.c = 2", "IMOR.e = 0.5, IMOR.c = 0.5")

# Use inverse-variance method for pooling (which is used for
# imputation methods)

m.publ.iv = update(m.publ, method = "Inverse")

# Combine results (random effects)

mbr = metabind(m.publ.iv,
               mmiss.0, mmiss.1,
               mmiss.pc, mmiss.pe, mmiss.p,
               mmiss.b, mmiss.w, mmiss.gh,
               mmiss.imor2, mmiss.imor0.5,
               name = meths, pooled = "random")

Create Figure 4 (file ‘figure4.pdf’).

forest(mbr, xlim = c(0.5, 4),
       leftcols = c("studlab", "I2.w", "tau2.w", "Q.w", "pval.Q.w"),
       leftlab = c("Meta-Analysis Method", "I2", "Tau2", "Q", "P-value"),
       type.study = "diamond",
       digits.addcols = c(4, 2, 2, 2), just.addcols = "right",
       file = "figure4.pdf", width = 10)
Section ‘Assessing and accounting for small-study effects’

Funnel plot

`funnel(m.publ)`

Harbord’s score test for funnel plot asymmetry

```
metabias(m.publ, method.bias = "score")
#> Linear regression test of funnel plot asymmetry
#> Test result: t = 4.56, df = 15, p-value = 0.0004
#> Bias estimate: 2.21 (SE = 0.4853)
#> Details:
#> - multiplicative residual heterogeneity variance (tau^2 = 1.0948)
#> - predictor: standard error of score
#> - weight: inverse variance of score
#> - reference: Harbord et al. (2006), Stat Med
```

Trim-and-fill method

```
tf.publ = trimfill(m.publ)
tf.publ
#> Number of studies: k = 26 (with 9 added studies)
#> Number of observations: o = 1174 (o.e = 645, o.c = 529)
#> Number of events: e = 374
#> Counts and RR
#> Quantifying heterogeneity:
#> tau^2 = 1.0983 [0.2929; 3.1894]; tau = 1.0480 [0.5412; 1.7859]
#> I^2 = 56.2% [32.1%; 71.8%]; H = 1.51 [1.21; 1.88]
#> Test of heterogeneity:
#> Q d.f. p-value
#> 57.13 25 0.0003
#>
#> Details on meta-analytical method:
#> - Inverse variance method
#> - Paule-Mandel estimator for tau^2
#> - Q-Profile method for confidence interval of tau^2 and tau
#> - Trim-and-fill method to adjust for funnel plot asymmetry (L-estimator)
```

```
summary(tf.publ)
#> RR  95%-CI %W(random)
#> Arvanitis (1997) 1.42 [0.89; 2.25] 6.2
#> Beasley (1996) 1.05 [0.73; 1.50] 6.4
#> Bechelli (1983) 6.21 [1.52; 25.35] 4.5
#> Borison (1992) 7.00 [0.40; 121.94] 2.2
#> Chouinard (1993) 3.49 [1.11; 10.95] 5.0
#> Durost (1964) 8.68 [1.26; 59.95] 3.5
#> Garry (1962) 1.75 [0.58; 5.24] 5.1
```
Howard (1974)  2.04 [0.67; 6.21]  5.1
Marder (1994)  1.36 [0.75; 2.47]  6.0
Nishikawa (1982)  3.00 [0.14; 65.55]  2.0
Nishikawa (1984)  9.00 [0.57; 142.29]  2.3
Reschke (1974)  3.79 [1.06; 13.60]  4.7
Selman (1976)  1.48 [0.94; 2.35]  6.2
Serafetinides (1972)  8.38 [0.50; 141.44]  2.3
Simpson (1967)  2.27 [0.12; 41.77]  2.2
Spencer (1992)  11.00 [1.67; 72.40]  3.6
Vichaiya (1971)  19.00 [1.16; 311.71]  2.3
Filled: Chouinard (1993)  0.50 [0.16; 1.55]  5.0
Filled: Reschke (1974)  0.46 [0.13; 1.64]  4.7
Filled: Bechelli (1983)  0.28 [0.07; 1.14]  4.5
Filled: Borison (1992)  0.25 [0.01; 4.31]  2.2
Filled: Serafetinides (1972)  0.21 [0.01; 3.49]  2.3
Filled: Durost (1964)  0.20 [0.03; 1.38]  3.5
Filled: Nishikawa (1984)  0.19 [0.01; 3.04]  2.3
Filled: Spencer (1992)  0.16 [0.02; 1.04]  3.6
Filled: Vichaiya (1971)  0.09 [0.01; 1.49]  2.3

Number of studies: k = 26 (with 9 added studies)
Number of observations: o = 1174 (o.e = 645, o.c = 529)
Number of events: e = 374

Random effects model  1.40 [0.83; 2.38]  1.26 0.2063

Quantifying heterogeneity:
tau^2 = 1.0983 [0.2929; 3.1894]; tau = 1.0480 [0.5412; 1.7859]
I^2 = 56.2% [32.1%; 71.8%]; H = 1.51 [1.21; 1.88]

Test of heterogeneity:
Q d.f. p-value
57.13 25 0.0003

Details on meta-analytical method:
- Inverse variance method
- Paule-Mandel estimator for tau^2
- Q-Profile method for confidence interval of tau^2 and tau
- Trim-and-fill method to adjust for funnel plot asymmetry (L-estimator)

funnel(tf.publ)

Limit meta-analysis

11.pub1 = limitmeta(m.pub1)

Note, the printout for the limit meta-analysis is not shown in this vignette as the installation of R package metasens is optional.

11.pub1

Create Figure 5 (file ‘figure5.pdf’).
pdf("figure5.pdf", width = 10, height = 10)
#
par(mfrow = c(2, 2), pty = "s",
     oma = c(0, 0, 0, 0), mar = c(4.1, 3.1, 2.1, 1.1))
#
funnel(m.publ, xlim = c(0.05, 50), axes = FALSE)
axis(1, at = c(0.1, 0.2, 0.5, 1, 2, 5, 10, 50))
axis(2, at = c(0, 0.5, 1, 1.5))
box()
title(main = "Panel A: Funnel plot", adj = 0)
#
funnel(m.publ, xlim = c(0.05, 50), axes = FALSE,
       contour.levels = c(0.9, 0.95, 0.99),
       col.contour = c("darkgray", "gray", "lightgray"))
legend("topright",
       c("p < 1%", "1% < p < 5%", "5% < p < 10%", "p > 10%"),
       fill = c("lightgray", "gray", "darkgray", "white"),
       border = "white", bg = "white")
axis(1, at = c(0.1, 0.2, 0.5, 1, 2, 5, 10, 50))
axis(2, at = c(0, 0.5, 1, 1.5))
box()
title(main = "Panel B: Contour-enhanced funnel plot", adj = 0)
#
funnel(tf.publ, xlim = c(0.05, 50), axes = FALSE)
axis(1, at = c(0.1, 0.2, 0.5, 1, 2, 5, 10, 50))
axis(2, at = c(0, 0.5, 1, 1.5))
box()
title(main = "Panel C: Trim-and-fill method", adj = 0)
#
funnel(l1.publ, xlim = c(0.05, 50), axes = FALSE,
       col.line = 8, lwd.line = 3)
axis(1, at = c(0.1, 0.2, 0.5, 1, 2, 5, 10, 50))
axis(2, at = c(0, 0.5, 1, 1.5))
box()
title(main = "Panel D: Limit meta-analysis", adj = 0)
#
dev.off()}
References