Meta-Analysis_Kinesiophobia_Physical_Activity

IM Lahart, MP Boisgontier

13 de June, 2024

Contents

R Markdown file set-up and packages

Packages required: 1) dmetar 2) tidyverse 3) meta 4) metafor 5) metasens 6) esc

Meta-analysis method

We pooled Pearson product-moment correlations from eligible studies to examine the relationship between kinesiophobia and physical activity. Correlations were pooled using the generic inverse pooling method via the ‘metacor’ function in the {meta} R package. This function automatically performs a necessary Fisher’s z-transformation on the original, untransformed correlations prior to pooling. The ‘metacor’ function also reconverts the pooled association back to its original form for ease of interpretation. Correlation estimates were nested within studies using the ‘cluster’ argument to account for the dependencies between these estimates, resulting in a three-level meta-analysis (level 1: participants, level 2: correlation estimates, level 3: studies). The distribution of variance across levels was assessed using the multilevel version of I2. The performance of the 2-level and 3-level meta-analyses was assessed and compared using the {metafor} R package.

We anticipated considerable between-study heterogeneity, and therefore used a random-effects model to pool correlations. The restricted maximum likelihood (RML) estimator (Viechtbauer, 2005) was used to calculate the heterogeneity variance Tau2. In addition to Tau2, to quantify between-study heterogeneity, we report the I2 statistic, which provides the percentage of variability in the correlations that is not caused by sampling error56. The I2 statistic was interpreted as follows: 0-40%, may not be important; 30-60%, may represent moderate heterogeneity; 50-90%, may represent substantial heterogeneity; and 75-100%, may represent considerable heterogeneity. To reduce the risk of false positives, we used a Knapp-Hartung adjustment (Knapp and Hartung, 2003) to calculate the confidence interval around the pooled association. We also report the prediction interval, which provides a range within which we can expect the associations of future studies to fall based on the current evidence. The pooled correlation was interpreted using Cohen’s conventions (Cohen, 1988): r -0.10, small negative correlation; r -0.30, moderate negative correlation; r -0.50, large negative correlation.

Publication bias was assessed using a funnel plot, which is a scatter plot of the studies’ effect size expressed as the Fisher’s z transformed correlation on the x-axis against a measure of their standard error (which is indicative of precision of the study’s effect size) on the y-axis. When there is no publication bias, the data points in a funnel plot should form a roughly symmetrical, upside-down funnel. Studies in the top part of the plot, which have lower standard errors, are expected to lie closely together, and not far away from the pooled effect size. In the lower part of the plot, studies have higher standard errors, the funnel “opens up”, and effect sizes are expected to scatter more heavily to the left and right of the pooled effect. Egger’s regression (Egger et al., 1997) can be used to formally test funnel plot’s asymmetry. However, since there is no direct function to conduct Egger’s test for 3-level models, we calculated it by using the standard errors of the effect size estimates as a predictor in the meta-regression60.

P-curve analysis (Simonsohn et al., 2014) was conducted to assess whether the distribution of the statistically significant results was consistent with what would be expected if only true effects were present. When the null hypothesis is true (i.e., there is no true effect), p-values are assumed to follow a uniform distribution: highly significant effects (e.g., $p = 0.01$) are as likely as barely significant effects (e.g., $p = 0.049$). However, when the null hypothesis is false (i.e., there is a true effect in our data), p-values are assumed to follow a right-skewed distribution: highly significant effects are more likely than barely significant effects. A left-skewed distribution would suggest that some studies used statistical tests to find significant results in ways that may not be reproducible or generalizable (i.e., p-hacking).

A secondary meta-analysis was conducted using the same approach, but based on Spearman's rho values, to further test the relationship between kinesiophobia and device-based physical activity.

Subgroup analyses were conducted to examine the differences in correlations between studies including participants with different health conditions and using different types of physical activity measures (i.e., device-based versus self-reported), physical activity measurement instruments (i.e., type of questionnaires, type of devices), physical activity outcomes, and kinesiophobia measures.

Exploratory meta-regressions were conducted to examine if the average age of participants, the proportion of women, and pain in a study predicted the reported correlation between kinesiophobia and physical activity. Pain was normalized to a 0-100 scale to make the data comparable across pain scales. A sensitivity analysis was conducted to examine whether the quality of the studies affected the results.

All analyses were performed in RStudio integrated development environment (IDE) (2023.06.1+524, "Mountain Hydrangea" release) for R software environment (R Core Team, 2023) using the 'meta' (Schwarzer, 2023), 'metasens' (Schwarzer et al., 2023), and 'metafor' (Vietchbauer, 2010, 2023) R packages.

Meta-analysis: primary analysis

Import Pearson r data

Data file glimpse (not included in PDF)

Primary analysis using metafor to compare models

```
m.cor <- rma.mv(yi = z, # pool correlation coefficients Fishers Z transformation https://bookdown.org/m
                V = var.z, # sampling variance of Fisher's Z values: 1/(N-3), where N = the sample size
                slab = author,
                data = Kinphob_r,
                random = ~ 1 | author/cor_id,
                test = "t",
                method = "REML")
summary(m.cor)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
## -11.1832   22.3664   28.3664   35.5865   28.6741
##
## Variance Components:
##
##              estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0576  0.2399     63     no         author
## sigma^2.2  0.0058  0.0762     83     no  author/cor_id
##
## Test for Heterogeneity:
## Q(df = 82) = 564.7688, p-val < .0001
```

```
##
## Model Results:
##
## estimate      se     tval  df    pval    ci.lb    ci.ub
##  -0.1956  0.0343  -5.6965  82  <.0001  -0.2639  -0.1273  ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Converting Fisher's z back to Pearson's r

```r
round(convert_z2r(-0.1956), 2) # point estimate
```

```
## [1] -0.19
```

```r
round(convert_z2r(-0.2639), 2) # lower CI
```

```
## [1] -0.26
```

```r
round(convert_z2r(-0.1273), 2) # Upper CI
```

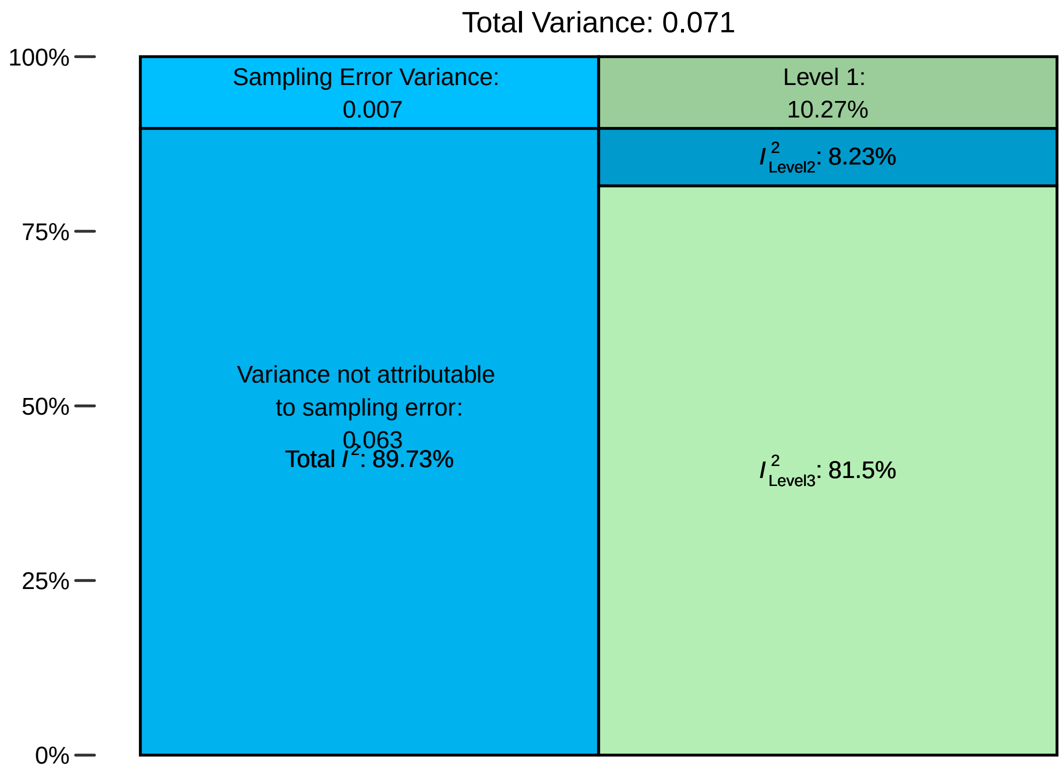
```
## [1] -0.13
```

Explore heterogeneity

```r
i2 <- var.comp(m.cor)
summary(i2)
```

```
##         % of total variance   I2
## Level 1           10.274387  ---
## Level 2            8.226472 8.23
## Level 3           81.499141 81.5
## Total I2: 89.73%
```

```r
plot(i2)
```



The sampling error variance on level 1 and the value of I2 on level 2, i.e., the amount of heterogeneity variance within studies, were small (10.3% and 8.2%, respectively). The largest share of heterogeneity variance was from level 3, with between-study heterogeneity making up 81.5% of the total variation in our data. Overall, this indicates that there is considerable between-study heterogeneity, and less than one tenth of the variance can be explained by differences within studies.

Comparing models

Reduced model in which the level 3 variance (between-study heterogeneity) is set to 0, which assumes all effect sizes are independent.

```
l3.removed <- rma.mv(yi = z,
                     V = var.z,
                     slab = author,
                     data = Kinphob_r,
                     random = ~ 1 | author/cor_id,
                     test = "t",
                     method = "REML",
                     sigma2 =  c(0, NA))

summary(l3.removed)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
## -17.5166   35.0333   39.0333   43.8467   39.1852
##
## Variance Components:
##
##               estim    sqrt  nlvls  fixed        factor
```

```
## sigma^2.1  0.0000  0.0000     63    yes         author
## sigma^2.2  0.0661  0.2571     83     no  author/cor_id
##
## Test for Heterogeneity:
## Q(df = 82) = 564.7688, p-val < .0001
##
## Model Results:
##
## estimate      se     tval  df    pval    ci.lb    ci.ub
##  -0.2159  0.0316  -6.8373  82  <.0001  -0.2787  -0.1531  ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Comparing full and reduced models.

```
anova(m.cor, l3.removed)
```

```
##
##         df     AIC     BIC    AICc   logLik     LRT   pval       QE
## Full     3 28.3664 35.5865 28.6741 -11.1832                564.7688
## Reduced  2 39.0333 43.8467 39.1852 -17.5166 12.6669 0.0004 564.7688
```

The 3-level model showed a better fit than the 2-level model with lower Akaike's information criterion (AIC) (28.4 vs. 39.0) and Bayesian information criterion (BIC) (35.6 vs. 43.8), indicating better performance. These lower AIC and BIC are consistent with the significant likelihood ratio test (LRT) comparing the two models (2 = 12.67, p = 0.0004). Therefore, although the 3-level model introduces an additional parameter, this added complexity has improved our estimate of the pooled effect.

Primary analysis using metacor

```
m <- metacor(cor = cor,
             n = n,
             studlab = author,
             data = Kinphob_r,
             cluster = cluster,
             fixed = FALSE,
             random = TRUE,
             method.tau = "REML",
             method.random.ci = "HK",
             prediction = TRUE,
             title = "Primary meta-analysis using metacor")

m
```

```
## Review:     Primary meta-analysis using metacor
##
## Number of studies: n = 63
## Number of estimates: k = 83
## Number of observations: o = 12278
##
##                          COR             95%-CI     t  p-value
## Random effects model -0.1931 [-0.2579; -0.1266] -5.70 < 0.0001
## Prediction interval          [-0.6051;  0.3004]
##
## Quantifying heterogeneity:
```

```
##  tau^2.1 = 0.0576 [0.0227; 0.0950]; tau.1 = 0.2399 [0.1508; 0.3082] (between cluster)
##  tau^2.2 = 0.0058 [0.0000; 0.0398]; tau.2 = 0.0762 [0.0000; 0.1995] (within cluster)
##  I^2 = 85.5% [82.6%; 87.9%]; H = 2.62 [2.40; 2.87]
##
## Test of heterogeneity:
##       Q d.f.  p-value
##  564.77   82 < 0.0001
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 82)
## - Prediction interval based on t-distribution (df = 81)
## - Fisher's z transformation of correlations
```

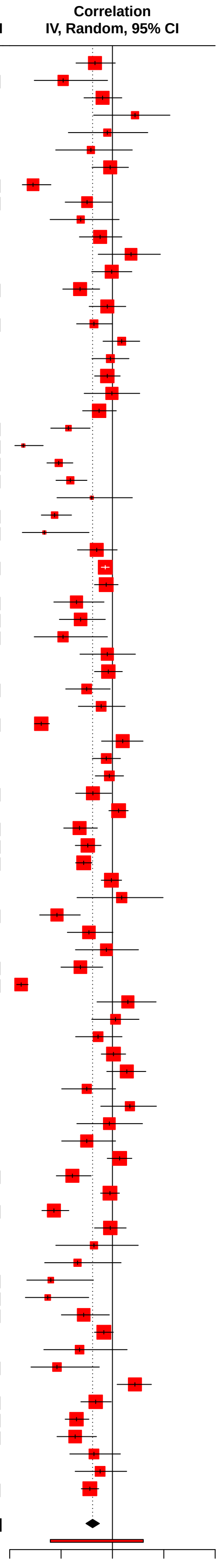
Our main meta-analysis of 63 studies, 83 Pearson's r correlation estimates, and 12278 participants revealed a statistically significant small-to-moderate negative correlation between kinesiophobia and physical activity ($r = -0.19$; 95% confidence interval [95CI]: -0.26 to -0.13; $p < 0.0001$). However, we observed substantial-to-considerable between-study statistical heterogeneity (Tau2 = 0.06, 95CI: 0.02 to 0.09; I2 = 85.5%, 95CI: 82.6 to 87.9%), and the prediction interval ranged from $r = -0.61$ to 0.30, indicating that a moderate positive correlation cannot be ruled out for future studies.

Primary meta-analysis forest plots

Forest plot with Pearson r correlation coefficients

```r
# Generate the forest plot without shading
forest(m,
       layout = "Revman5",
            prediction = TRUE,
            print.tau2 = FALSE,
            leftlabs = c("Author", "n"),
            xlim=c(-1.0,1.0),
            fs.hetstat = 10,
            addrows.below.overall = 2)
```

Study	Cluster	Total	Weight	Correlation IV, Random, 95% CI
Alamam, 2019	sample_1	100	1.6%	−0.17 [−0.35; 0.03]
Alschuler, 2011	sample_2	20	1.0%	−0.48 [−0.76; −0.05]
Altug, 2016	sample_3	112	1.6%	−0.10 [−0.28; 0.09]
Alzahrani, 2021	sample_4	26	0.5%	0.22 [−0.18; 0.56]
Alzahrani, 2021	sample_4	26	0.5%	−0.05 [−0.43; 0.34]
Alzahrani, 2021	sample_4	26	0.5%	−0.21 [−0.55; 0.19]
Assadourian, 2020	sample_5	123	1.6%	−0.02 [−0.20; 0.16]
Aydemir, 2022	sample_6	37	1.3%	−0.77 [−0.88; −0.60]
Aykut Selcuk, 2020	sample_7	67	1.1%	−0.25 [−0.46; −0.01]
Aykut Selcuk, 2020	sample_7	29	0.5%	−0.31 [−0.61; 0.06]
Baday−Keskin, 2022	sample_8	88	1.6%	−0.12 [−0.32; 0.09]
Baez, 2020	sample_9	40	1.3%	0.18 [−0.14; 0.47]
Bahar Ozdemir, 2021	sample_10	101	1.6%	−0.01 [−0.20; 0.19]
Baykal Sahin, 2021	sample_11	98	1.6%	−0.32 [−0.48; −0.12]
Bernard, 2015	sample_12	121	1.6%	−0.05 [−0.23; 0.13]
Carvalho, 2017	sample_13	119	0.6%	−0.18 [−0.35; −0.00]
Carvalho, 2017	sample_13	119	0.6%	0.09 [−0.09; 0.27]
Carvalho, 2017	sample_13	119	0.6%	−0.02 [−0.20; 0.16]
Coronado, 2021	sample_14	248	1.7%	−0.05 [−0.17; 0.08]
Corrigan, 2018	sample_15	53	1.4%	−0.00 [−0.27; 0.27]
Cromert, 2021	sample_16	139	1.7%	−0.13 [−0.29; 0.04]
Dabek, 2020	sample_17	72	0.3%	−0.43 [−0.60; −0.22]
Dabek, 2020	sample_17	18	0.1%	−0.87 [−0.95; −0.67]
Dabek, 2020	sample_17	130	0.5%	−0.52 [−0.64; −0.39]
Dabek, 2020	sample_17	119	0.5%	−0.41 [−0.55; −0.25]
Dabek, 2020	sample_17	27	0.1%	−0.20 [−0.54; 0.19]
Dabek, 2020	sample_17	86	0.4%	−0.56 [−0.69; −0.40]
Dabek, 2020	sample_17	15	0.1%	−0.66 [−0.88; −0.23]
Demirbuken, 2016	sample_18	99	1.6%	−0.15 [−0.34; 0.05]
Demmelmaier, 2018	sample_19	2569	1.8%	−0.07 [−0.11; −0.03]
Dogan, 2022	sample_20	290	1.8%	−0.06 [−0.17; 0.05]
Donnarumma, 2017	sample_21	51	1.4%	−0.35 [−0.57; −0.08]
Elfving, 2007	sample_22	64	1.5%	−0.31 [−0.52; −0.07]
Glaviano, 2017	sample_23	20	1.0%	−0.48 [−0.76; −0.05]
Helmus, 2012	sample_24	53	1.4%	−0.05 [−0.32; 0.22]
Ho−A−Tham, 2022	sample_25	210	1.7%	−0.04 [−0.17; 0.10]
Igelstrom, 2013	sample_26	73	0.9%	−0.25 [−0.45; −0.02]
Igelstrom, 2013	sample_26	73	0.9%	−0.11 [−0.33; 0.12]
Kilinc, 2019	sample_27	200	1.7%	−0.69 [−0.76; −0.61]
Koho, 2011	sample_28	93	1.6%	0.10 [−0.11; 0.30]
Koppenaal, 2023	sample_29	204	0.9%	−0.06 [−0.20; 0.08]
Koppenaal, 2023	sample_29	204	0.9%	−0.03 [−0.17; 0.11]
Lotzke, 2018	sample_30	118	1.6%	−0.19 [−0.36; −0.01]
Luthi, 2022	sample_31	433	1.8%	0.06 [−0.03; 0.15]
Marques−Sule, 2022	sample_32	117	1.6%	−0.32 [−0.47; −0.15]
Marshall, 2017	sample_33	218	1.7%	−0.24 [−0.36; −0.11]
Marshall, 2021	sample_34	508	1.8%	−0.28 [−0.36; −0.20]
Marshall, 2022	sample_35	393	1.8%	−0.01 [−0.11; 0.09]
Masse−Alarie, 2016	sample_36	22	1.0%	0.09 [−0.34; 0.49]
Miller, 2018	sample_37	52	1.4%	−0.54 [−0.71; −0.31]
Minetama, 2022	sample_38	71	1.5%	−0.23 [−0.44; 0.00]
Navarro−Ledesma, 2022	sample_39	41	1.3%	−0.06 [−0.36; 0.25]
Norte, 2019	sample_40	77	1.5%	−0.31 [−0.50; −0.09]
Ozer, 2022	sample_41	62	1.5%	−0.89 [−0.93; −0.82]
Ozlu, 2022	sample_42	45	1.4%	0.15 [−0.15; 0.42]
Palstam, 2014	sample_43	73	0.9%	0.03 [−0.20; 0.26]
Palstam, 2014	sample_43	73	0.9%	−0.14 [−0.36; 0.09]
Pastor−Mira, 2020	sample_44	274	1.8%	0.01 [−0.11; 0.13]
Pedler, 2018	sample_45	103	1.6%	0.14 [−0.06; 0.32]
Peres, 2023	sample_46	50	0.8%	−0.25 [−0.49; 0.03]
Peres, 2023	sample_46	50	0.8%	0.17 [−0.11; 0.43]
Polaski, 2021	sample_47	38	1.3%	−0.03 [−0.35; 0.29]
Priore, 2020	sample_48	50	1.4%	−0.25 [−0.49; 0.03]
Rabey, 2017	sample_49	266	1.8%	0.07 [−0.05; 0.19]
Roaldsen, 2009	sample_50	98	1.6%	−0.39 [−0.55; −0.21]
Sandal, 2021	sample_51	460	1.8%	−0.02 [−0.12; 0.07]
Saulicz, 2016	sample_52	105	1.6%	−0.57 [−0.69; −0.42]
Sertel, 2021	sample_53	163	1.7%	−0.02 [−0.17; 0.13]
Smulligan, 2023	sample_54	23	0.5%	−0.18 [−0.55; 0.25]
Smulligan, 2023	sample_54	23	0.5%	−0.34 [−0.66; 0.08]
Smulligan, 2023	sample_54	18	0.3%	−0.60 [−0.83; −0.18]
Smulligan, 2023	sample_54	18	0.3%	−0.63 [−0.85; −0.23]
Spaderna, 2020	sample_55	61	1.5%	−0.28 [−0.50; −0.03]
Strandberg, 2022	sample_56	451	1.8%	−0.08 [−0.17; 0.01]
Sutcu, 2021	sample_57	20	0.7%	−0.32 [−0.67; 0.14]
Sutcu, 2021	sample_57	20	0.7%	−0.54 [−0.79; −0.13]
Suttmiller, 2022	sample_58	126	1.6%	0.22 [0.05; 0.38]
Uritani, 2020	sample_59	167	1.7%	−0.16 [−0.31; −0.01]
Wang , 2023	sample_60	223	1.7%	−0.35 [−0.46; −0.23]
Wasiuk−Zowada, 2022	sample_61	80	1.5%	−0.36 [−0.54; −0.16]
Zadro, 2019	sample_62	60	0.9%	−0.18 [−0.41; 0.08]
Zadro, 2019	sample_62	60	0.9%	−0.12 [−0.36; 0.14]
Zelle, 2016	sample_63	487	1.8%	−0.22 [−0.30; −0.13]
Total (95% CI)		**12278**	**100.0%**	**−0.19 [−0.26; −0.13]**
Prediction interval				**[−0.61; 0.30]**



Heterogeneity: $Tau^2 = 0.0634$; $Chi^2 = 564.77$, df = 82 ($P < 0.01$); $I^2 = 85\%$

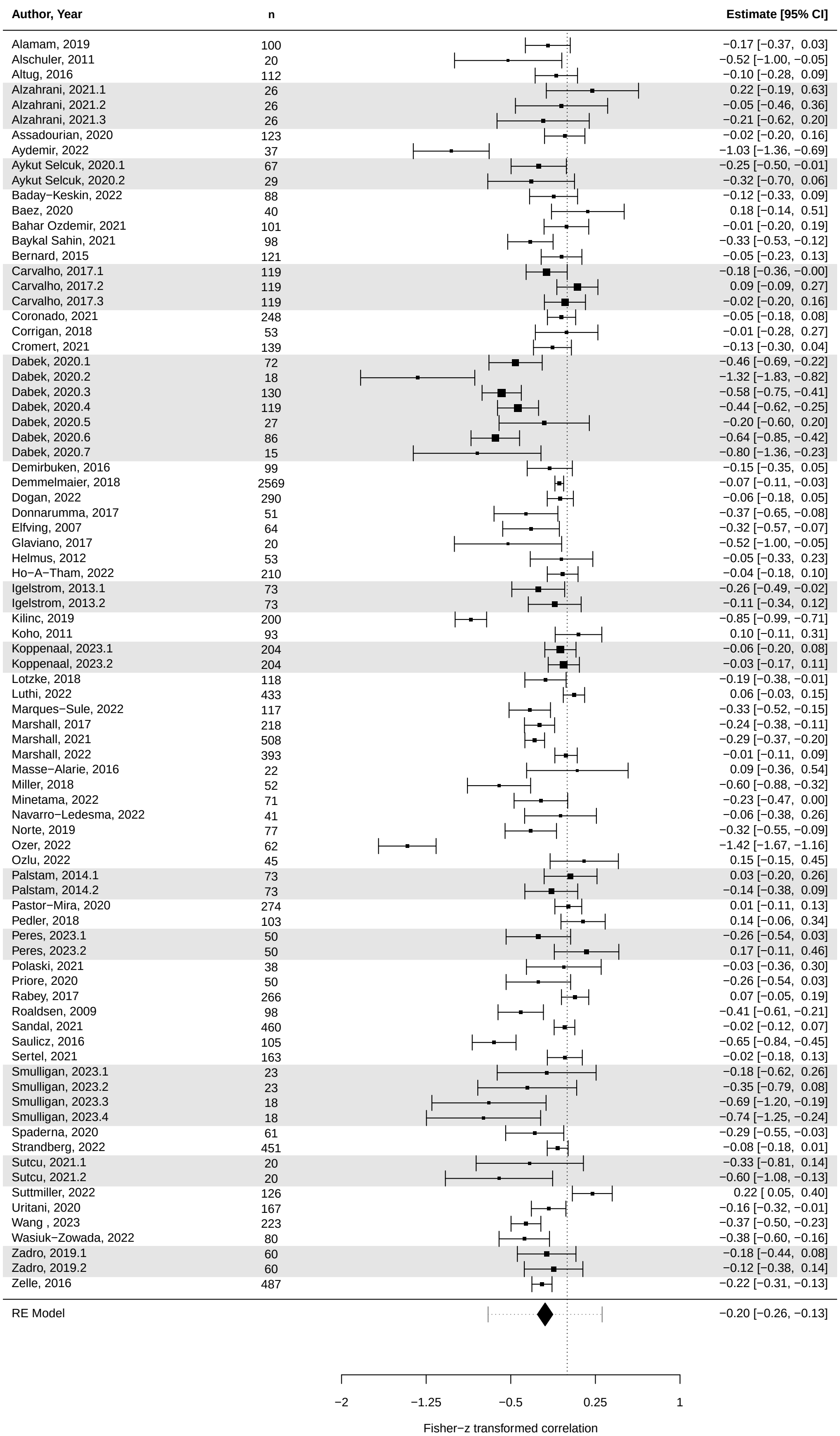
Save Forest plot:

```
png(file = "Main analysis forestplot.png",
    width = 2800, height = 4000, res = 300)

forest(m,
       xlim = c(-1.0, 0.6),
       layout = "Revman")

dev.off()
```

```
## pdf
##   2
```

Forest plot with Fisher z transformed correlation coefficients

```
forest(m.cor,
       cex=0.8,
       addpred=TRUE,
       alim=c(-2,1),
       xlab = "Fisher-z transformed correlation",
       ilab = n,
       header="Author, Year",
       shade=c(2,3,8,9,12,13,14,15,23,24,27,28,42,43,46,47,56,57,58,59,60,61,62,66,67,68,74,75,78,79,80
text(c(-2.62), m.cor$k+2, c("n"), cex=0.75, font=2)
```


Author, Year
n
Estimate [95% CI]
Alamam, 2019 100 −0.17 [−0.37, 0.03]
Alschuler, 2011 20 −0.52 [−1.00, −0.05]
Altug, 2016 112 −0.10 [−0.28, 0.09]
Alzahrani, 2021.1 26 0.22 [−0.19, 0.63]
Alzahrani, 2021.2 26 −0.05 [−0.46, 0.36]
Alzahrani, 2021.3 26 −0.21 [−0.62, 0.20]
Assadourian, 2020 123 −0.02 [−0.20, 0.16]
Aydemir, 2022 37 −1.03 [−1.36, −0.69]
Aykut Selcuk, 2020.1 67 −0.25 [−0.50, −0.01]
Aykut Selcuk, 2020.2 29 −0.32 [−0.70, 0.06]
Baday−Keskin, 2022 88 −0.12 [−0.33, 0.09]
Baez, 2020 40 0.18 [−0.14, 0.51]
Bahar Ozdemir, 2021 101 −0.01 [−0.20, 0.19]
Baykal Sahin, 2021 98 −0.33 [−0.53, −0.12]
Bernard, 2015 121 −0.05 [−0.23, 0.13]
Carvalho, 2017.1 119 −0.18 [−0.36, −0.00]
Carvalho, 2017.2 119 0.09 [−0.09, 0.27]
Carvalho, 2017.3 119 −0.02 [−0.20, 0.16]
Coronado, 2021 248 −0.05 [−0.18, 0.08]
Corrigan, 2018 53 −0.01 [−0.28, 0.27]
Cromert, 2021 139 −0.13 [−0.30, 0.04]
Dabek, 2020.1 72 −0.46 [−0.69, −0.22]
Dabek, 2020.2 18 −1.32 [−1.83, −0.82]
Dabek, 2020.3 130 −0.58 [−0.75, −0.41]
Dabek, 2020.4 119 −0.44 [−0.62, −0.25]
Dabek, 2020.5 27 −0.20 [−0.60, 0.20]
Dabek, 2020.6 86 −0.64 [−0.85, −0.42]
Dabek, 2020.7 15 −0.80 [−1.36, −0.23]
Demirbuken, 2016 99 −0.15 [−0.35, 0.05]
Demmelmaier, 2018 2569 −0.07 [−0.11, −0.03]
Dogan, 2022 290 −0.06 [−0.18, 0.05]
Donnarumma, 2017 51 −0.37 [−0.65, −0.08]
Elfving, 2007 64 −0.32 [−0.57, −0.07]
Glaviano, 2017 20 −0.52 [−1.00, −0.05]
Helmus, 2012 53 −0.05 [−0.33, 0.23]
Ho−A−Tham, 2022 210 −0.04 [−0.18, 0.10]
Igelstrom, 2013.1 73 −0.26 [−0.49, −0.02]
Igelstrom, 2013.2 73 −0.11 [−0.34, 0.12]
Kilinc, 2019 200 −0.85 [−0.99, −0.71]
Koho, 2011 93 0.10 [−0.11, 0.31]
Koppenaal, 2023.1 204 −0.06 [−0.20, 0.08]
Koppenaal, 2023.2 204 −0.03 [−0.17, 0.11]
Lotzke, 2018 118 −0.19 [−0.38, −0.01]
Luthi, 2022 433 0.06 [−0.03, 0.15]
Marques−Sule, 2022 117 −0.33 [−0.52, −0.15]
Marshall, 2017 218 −0.24 [−0.38, −0.11]
Marshall, 2021 508 −0.29 [−0.37, −0.20]
Marshall, 2022 393 −0.01 [−0.11, 0.09]
Masse−Alarie, 2016 22 0.09 [−0.36, 0.54]
Miller, 2018 52 −0.60 [−0.88, −0.32]
Minetama, 2022 71 −0.23 [−0.47, 0.00]
Navarro−Ledesma, 2022 41 −0.06 [−0.38, 0.26]
Norte, 2019 77 −0.32 [−0.55, −0.09]
Ozer, 2022 62 −1.42 [−1.67, −1.16]
Ozlu, 2022 45 0.15 [−0.15, 0.45]
Palstam, 2014.1 73 0.03 [−0.20, 0.26]
Palstam, 2014.2 73 −0.14 [−0.38, 0.09]
Pastor−Mira, 2020 274 0.01 [−0.11, 0.13]
Pedler, 2018 103 0.14 [−0.06, 0.34]
Peres, 2023.1 50 −0.26 [−0.54, 0.03]
Peres, 2023.2 50 0.17 [−0.11, 0.46]
Polaski, 2021 38 −0.03 [−0.36, 0.30]
Priore, 2020 50 −0.26 [−0.54, 0.03]
Rabey, 2017 266 0.07 [−0.05, 0.19]
Roaldsen, 2009 98 −0.41 [−0.61, −0.21]
Sandal, 2021 460 −0.02 [−0.12, 0.07]
Saulicz, 2016 105 −0.65 [−0.84, −0.45]
Sertel, 2021 163 −0.02 [−0.18, 0.13]
Smulligan, 2023.1 23 −0.18 [−0.62, 0.26]
Smulligan, 2023.2 23 −0.35 [−0.79, 0.08]
Smulligan, 2023.3 18 −0.69 [−1.20, −0.19]
Smulligan, 2023.4 18 −0.74 [−1.25, −0.24]
Spaderna, 2020 61 −0.29 [−0.55, −0.03]
Strandberg, 2022 451 −0.08 [−0.18, 0.01]
Sutcu, 2021.1 20 −0.33 [−0.81, 0.14]
Sutcu, 2021.2 20 −0.60 [−1.08, −0.13]
Suttmiller, 2022 126 0.22 [0.05, 0.40]
Uritani, 2020 167 −0.16 [−0.32, −0.01]
Wang , 2023 223 −0.37 [−0.50, −0.23]
Wasiuk−Zowada, 2022 80 −0.38 [−0.60, −0.16]
Zadro, 2019.1 60 −0.18 [−0.44, 0.08]
Zadro, 2019.2 60 −0.12 [−0.38, 0.14]
Zelle, 2016 487 −0.22 [−0.31, −0.13]
RE Model −0.20 [−0.26, −0.13]
−2
−1.25
−0.5
0.25
1
Fisher−z transformed correlation

Save plot:

```
png(file = "Main analysis Fisher z forest plot.png",
    width = 2800, height = 4000, res = 300)

forest(m.cor,
       cex=0.8,
       addpred=TRUE,
       alim=c(-2,2),
       xlab = "Fisher-z transformed correlation",
       ilab = n,
       header="Author(s), Year, estimate n",
       shade=c(1,2,4,5,12,13,14,15,23,24,34,35,36,40,41,44,45,50,51,52,53,54,55,56,65,66,69,70,71)) # f
text(c(-2.62), m.cor$k+2, c("n"), cex=0.75, font=2)

dev.off()
```

```
## pdf
##   2
```

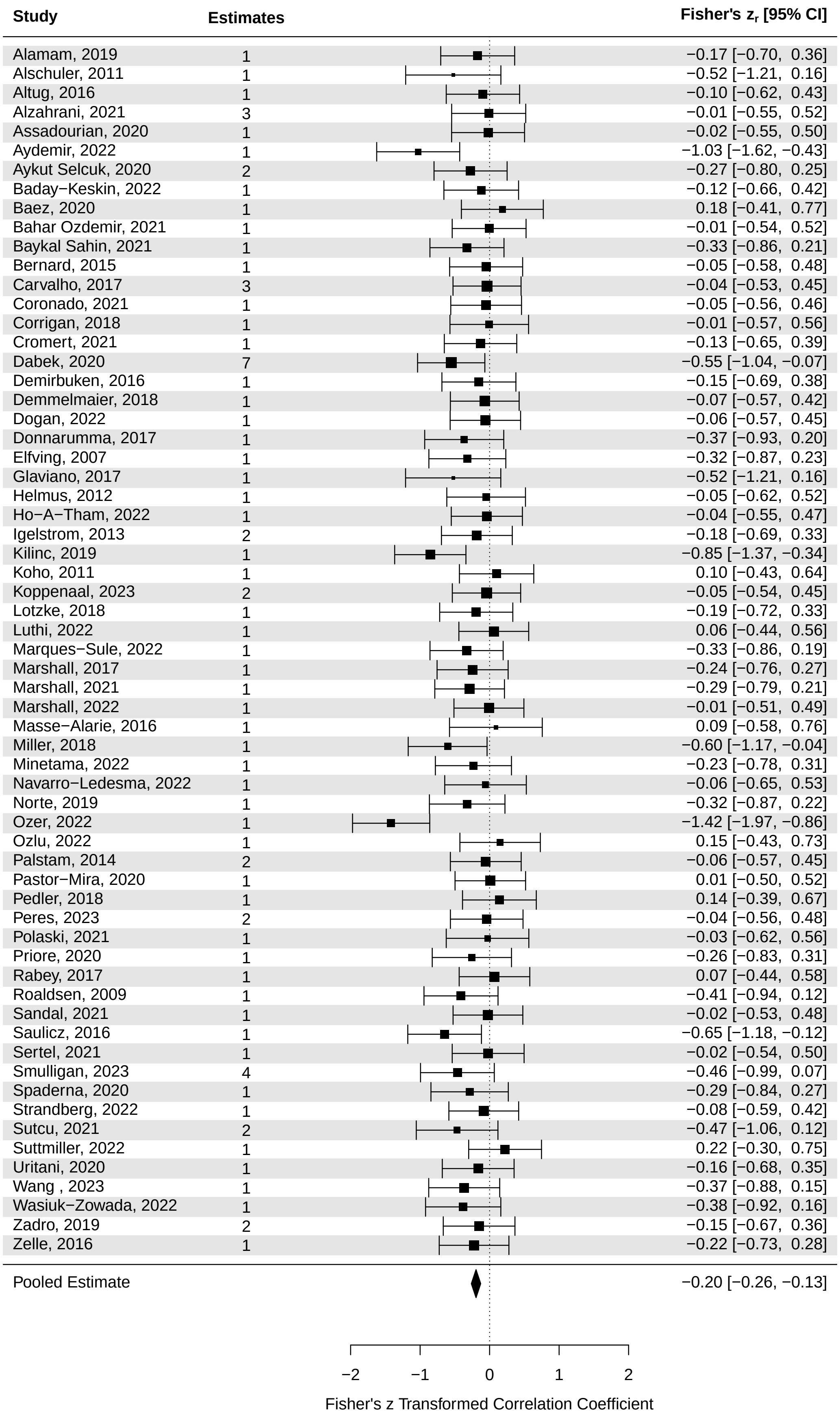
Forest plot with aggregated Fisher z values

```
dat_r <- escalc(measure="ZCOR",
                yi=z,
                vi=var.z,
                slab = author,
                data=Kinphob_r)

agg <- aggregate(dat_r,
                 cluster=author,
                 V = vcov(m.cor,
                 type="obs"),
                 struct="ID",
                 addk=TRUE)

res <- rma(yi,
           vi,
           method="EE",
           data=agg,
           digits=2)
res
```

```
##
## Equal-Effects Model (k = 63)
##
## I^2 (total heterogeneity / total variability):   4.39%
## H^2 (total variability / sampling variability):  1.05
##
## Test for Heterogeneity:
## Q(df = 62) = 64.85, p-val = 0.38
##
## Model Results:
##
## estimate    se    zval   pval   ci.lb   ci.ub
##    -0.20  0.03  -5.70  <.01  -0.26  -0.13  ***
```

```
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
forest(res,
       xlim=c(-7,5),
       mlab="Pooled Estimate",
       header=TRUE,
       alim=c(-2,2),
       slab = author,
       ilab=ki,
       ilab.xpos=-3.5,
       shade = "zebra")
text(-3.5, res$k+2, "Estimates", font=2)
```


Study
Estimates
Fisher's z_r [95% CI]
Alamam, 2019 1 −0.17 [−0.70, 0.36]
Alschuler, 2011 1 −0.52 [−1.21, 0.16]
Altug, 2016 1 −0.10 [−0.62, 0.43]
Alzahrani, 2021 3 −0.01 [−0.55, 0.52]
Assadourian, 2020 1 −0.02 [−0.55, 0.50]
Aydemir, 2022 1 −1.03 [−1.62, −0.43]
Aykut Selcuk, 2020 2 −0.27 [−0.80, 0.25]
Baday−Keskin, 2022 1 −0.12 [−0.66, 0.42]
Baez, 2020 1 0.18 [−0.41, 0.77]
Bahar Ozdemir, 2021 1 −0.01 [−0.54, 0.52]
Baykal Sahin, 2021 1 −0.33 [−0.86, 0.21]
Bernard, 2015 1 −0.05 [−0.58, 0.48]
Carvalho, 2017 3 −0.04 [−0.53, 0.45]
Coronado, 2021 1 −0.05 [−0.56, 0.46]
Corrigan, 2018 1 −0.01 [−0.57, 0.56]
Cromert, 2021 1 −0.13 [−0.65, 0.39]
Dabek, 2020 7 −0.55 [−1.04, −0.07]
Demirbuken, 2016 1 −0.15 [−0.69, 0.38]
Demmelmaier, 2018 1 −0.07 [−0.57, 0.42]
Dogan, 2022 1 −0.06 [−0.57, 0.45]
Donnarumma, 2017 1 −0.37 [−0.93, 0.20]
Elfving, 2007 1 −0.32 [−0.87, 0.23]
Glaviano, 2017 1 −0.52 [−1.21, 0.16]
Helmus, 2012 1 −0.05 [−0.62, 0.52]
Ho−A−Tham, 2022 1 −0.04 [−0.55, 0.47]
Igelstrom, 2013 2 −0.18 [−0.69, 0.33]
Kilinc, 2019 1 −0.85 [−1.37, −0.34]
Koho, 2011 1 0.10 [−0.43, 0.64]
Koppenaal, 2023 2 −0.05 [−0.54, 0.45]
Lotzke, 2018 1 −0.19 [−0.72, 0.33]
Luthi, 2022 1 0.06 [−0.44, 0.56]
Marques−Sule, 2022 1 −0.33 [−0.86, 0.19]
Marshall, 2017 1 −0.24 [−0.76, 0.27]
Marshall, 2021 1 −0.29 [−0.79, 0.21]
Marshall, 2022 1 −0.01 [−0.51, 0.49]
Masse−Alarie, 2016 1 0.09 [−0.58, 0.76]
Miller, 2018 1 −0.60 [−1.17, −0.04]
Minetama, 2022 1 −0.23 [−0.78, 0.31]
Navarro−Ledesma, 2022 1 −0.06 [−0.65, 0.53]
Norte, 2019 1 −0.32 [−0.87, 0.22]
Ozer, 2022 1 −1.42 [−1.97, −0.86]
Ozlu, 2022 1 0.15 [−0.43, 0.73]
Palstam, 2014 2 −0.06 [−0.57, 0.45]
Pastor−Mira, 2020 1 0.01 [−0.50, 0.52]
Pedler, 2018 1 0.14 [−0.39, 0.67]
Peres, 2023 2 −0.04 [−0.56, 0.48]
Polaski, 2021 1 −0.03 [−0.62, 0.56]
Priore, 2020 1 −0.26 [−0.83, 0.31]
Rabey, 2017 1 0.07 [−0.44, 0.58]
Roaldsen, 2009 1 −0.41 [−0.94, 0.12]
Sandal, 2021 1 −0.02 [−0.53, 0.48]
Saulicz, 2016 1 −0.65 [−1.18, −0.12]
Sertel, 2021 1 −0.02 [−0.54, 0.50]
Smulligan, 2023 4 −0.46 [−0.99, 0.07]
Spaderna, 2020 1 −0.29 [−0.84, 0.27]
Strandberg, 2022 1 −0.08 [−0.59, 0.42]
Sutcu, 2021 2 −0.47 [−1.06, 0.12]
Suttmiller, 2022 1 0.22 [−0.30, 0.75]
Uritani, 2020 1 −0.16 [−0.68, 0.35]
Wang , 2023 1 −0.37 [−0.88, 0.15]
Wasiuk−Zowada, 2022 1 −0.38 [−0.92, 0.16]
Zadro, 2019 2 −0.15 [−0.67, 0.36]
Zelle, 2016 1 −0.22 [−0.73, 0.28]
Pooled Estimate −0.20 [−0.26, −0.13]
−2
−1
0
1
2
Fisher's z Transformed Correlation Coefficient

Save plot:

```
png(file = "Main analysis aggregated forestplot.png",
    width = 2800, height = 4000, res = 300)

forest(res,
       xlim=c(-7,5),
       mlab="Pooled Estimate",
       header=TRUE,
       alim=c(-2.5,2.5),
       slab = author,
       ilab=ki,
       ilab.xpos=-3.5,
       shade = "zebra")
text(-3.5, res$k+2, "Estimates", font=2)

dev.off()
```

```
## pdf
##   2
```

Secondary analysis based on Spearman's rho values

Read in rho data

```
Kinphob_rho <- read.csv("2024-05-02_meta_analysis_kinesiophobia_rho.csv",
                        header = TRUE, sep = ",")
```

Secondary analysis using metafor to compare models

```
m.cor.rho <- rma.mv(yi = z,
                    V = var.z,
                    slab = author,
                    data = Kinphob_rho,
                    random = ~ 1 | author/cor_id,
                    test = "t",
                    method = "REML")
summary(m.cor.rho)
```

```
##
## Multivariate Meta-Analysis Model (k = 21; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
##   0.6454   -1.2908    4.7092    7.6964    6.2092
##
## Variance Components:
##
##              estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0982  0.3134     12     no         author
## sigma^2.2  0.0000  0.0000     21     no  author/cor_id
##
## Test for Heterogeneity:
## Q(df = 20) = 146.0167, p-val < .0001
##
```

```
## Model Results:
##
## estimate      se     tval  df    pval    ci.lb    ci.ub
##  -0.2018  0.0961  -2.1003  20  0.0486  -0.4023  -0.0014  *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
round(convert_z2r(-0.0959), 3) # point estimate
```

```
## [1] -0.096
```

```r
round(convert_z2r(-0.4017), 3) # lower CI
```

```
## [1] -0.381
```

```r
round(convert_z2r(-0.0017), 3) # Upper CI
```

```
## [1] -0.002
```

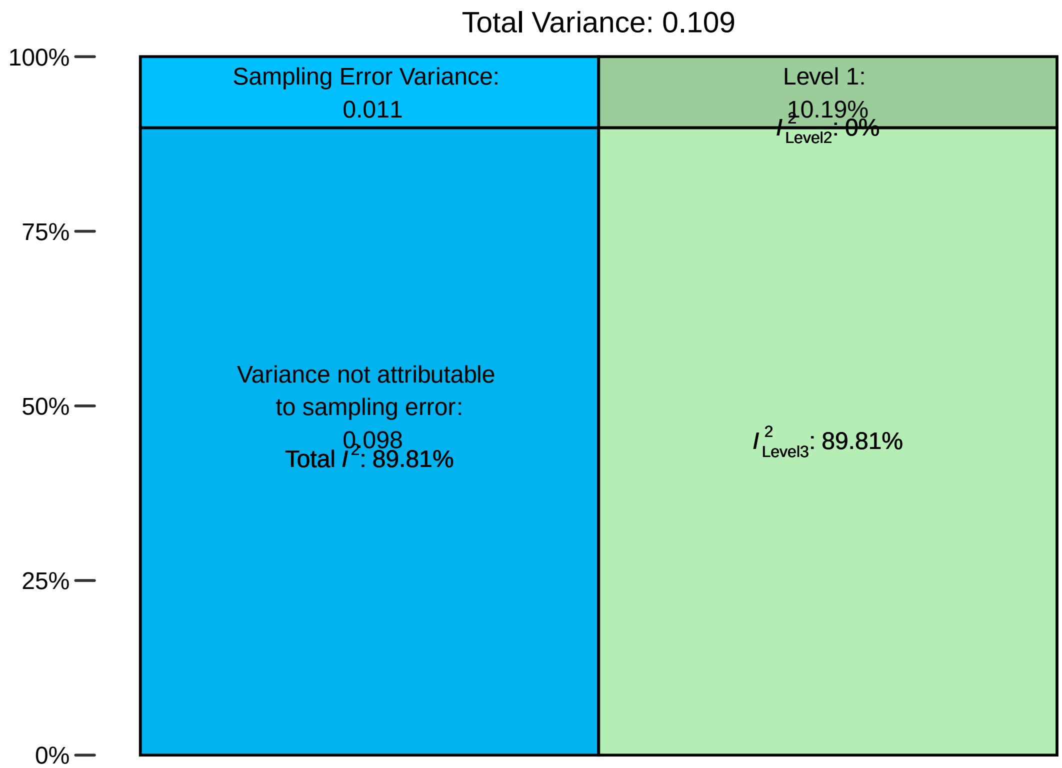
Results of the secondary meta-analysis of 12 studies, 21 Spearman's rho correlation estimates, and 2084 participants was consistent with the main meta-analysis as it showed a statistically significant small-to-moderate negative correlation between kinesiophobia and physical activity (r = -0.20; 95CI: -0.38 to -0.01; p = 0.049). However, we observed substantial-to-considerable between-study statistical heterogeneity (Tau2 = 0.10, 95CI: 0.04 to 0.28; I2 = 86.3%) and the prediction interval ranged from r = -0.71 to 0.45, indicating that a moderate positive correlation cannot be ruled out for future studies.

Explore heterogeneity, rho

```r
i2_rho <- var.comp(m.cor.rho)
summary(i2_rho)
```

```
##         % of total variance    I2
## Level 1        1.018861e+01   ---
## Level 2        2.089253e-10     0
## Level 3        8.981139e+01 89.81
## Total I2: 89.81%
```

```r
plot(i2_rho)
```



The value of I2 Level 2, the amount of heterogeneity variance within clusters (i.e. within studies), is very low, totaling roughly 0%. The largest share, however, falls to level 3. Between-cluster (here: between-study) heterogeneity makes up I2 Level 3 = 96.8% of the total variation in our data. Overall, this indicates that there is considerable between-study heterogeneity on the third level, and very little of the variance can be explained by differences within studies.

Compare models, rho

```
l3.removed_rho <- rma.mv(yi = z,
                     V = var.z,
                     slab = author,
                     data = Kinphob_rho,
                     random = ~ 1 | author/cor_id,
                     test = "t",
                     method = "REML",
                     sigma2 =  c(0, NA))

summary(l3.removed_rho)
```

```
##
## Multivariate Meta-Analysis Model (k = 21; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
##  -3.1233    6.2465   10.2465   12.2380   10.9524
##
## Variance Components:
##
##              estim    sqrt  nlvls  fixed         factor
## sigma^2.1   0.0000  0.0000     12    yes         author
## sigma^2.2   0.0649  0.2548     21     no  author/cor_id
```

```
##
## Test for Heterogeneity:
## Q(df = 20) = 146.0167, p-val < .0001
##
## Model Results:
##
## estimate      se     tval  df    pval    ci.lb    ci.ub
##  -0.1782  0.0644  -2.7655  20  0.0119  -0.3126  -0.0438  *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(m.cor.rho, l3.removed_rho)
```

```
##
##         df     AIC     BIC    AICc  logLik    LRT   pval       QE
## Full     3  4.7092  7.6964  6.2092  0.6454               146.0167
## Reduced  2 10.2465 12.2380 10.9524 -3.1233 7.5374 0.0060 146.0167
```

Modeling of the nested data structure was probably a good idea, and has improved our estimate of the pooled effect.

Secondary meta-analysis using metacor

```
m.rho <- metacor(cor = rho,
              n = n,
              studlab = author,
              data = Kinphob_rho,
              cluster = cluster,
              fixed = FALSE,
              random = TRUE,
              method.tau = "REML",
              method.random.ci = "HK",
              prediction = TRUE,
              title = "Secondary meta-analysis using metacor")

m.rho
```

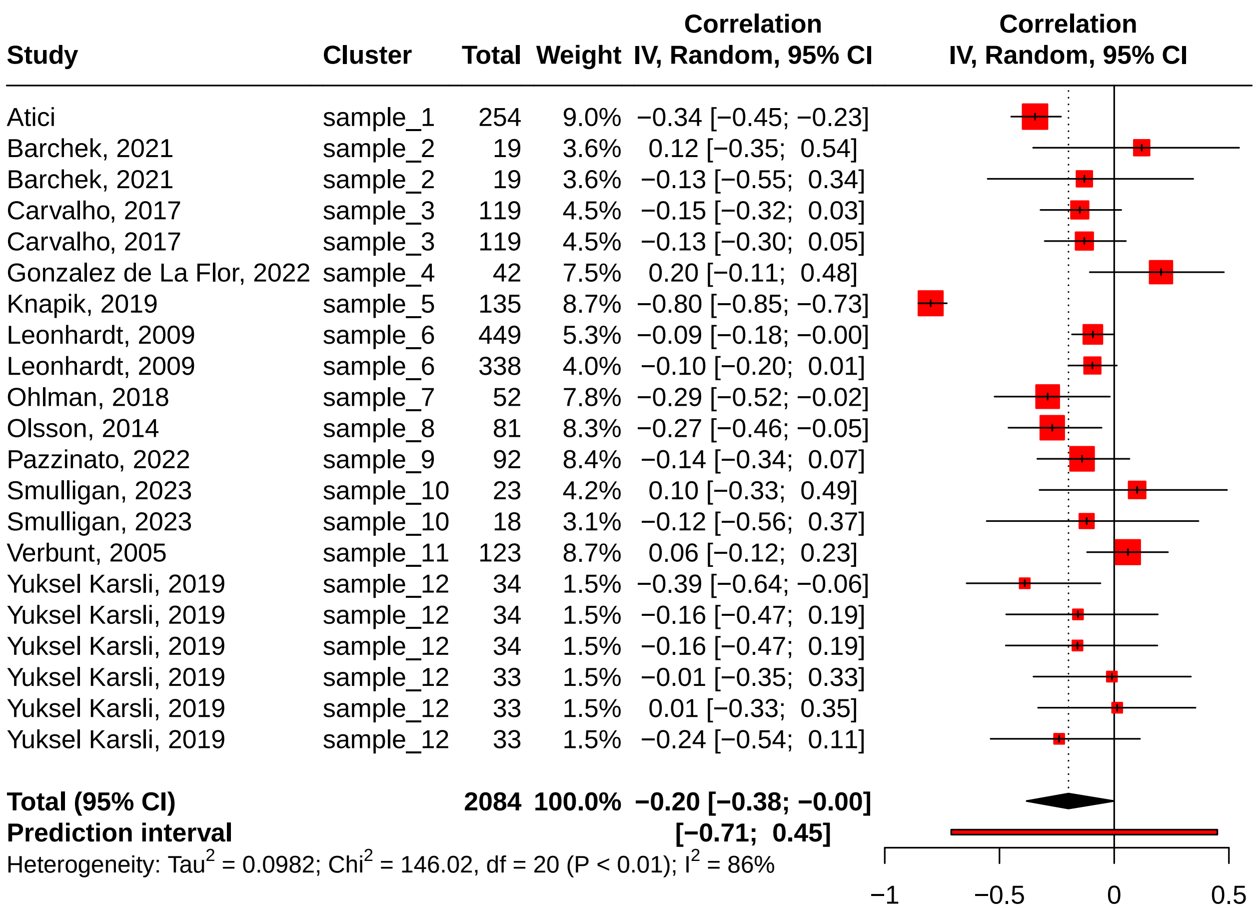
```
## Review:     Secondary meta-analysis using metacor
##
## Number of studies: n = 12
## Number of estimates: k = 21
## Number of observations: o = 2084
##
##                           COR             95%-CI     t p-value
## Random effects model -0.1991 [-0.3819; -0.0014] -2.10  0.0486
## Prediction interval          [-0.7104;  0.4497]
##
## Quantifying heterogeneity:
##  tau^2.1 = 0.0982 [0.0418; 0.2771]; tau.1 = 0.3134 [0.2044; 0.5264] (between cluster)
##  tau^2.2 < 0.0001 [0.0000; 0.0172]; tau.2 < 0.0001 [0.0000; 0.1312] (within cluster)
##  I^2 = 86.3% [80.4%; 90.4%]; H = 2.70 [2.26; 3.23]
##
## Test of heterogeneity:
##       Q d.f.  p-value
```

```
##   146.02    20 < 0.0001
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 20)
## - Prediction interval based on t-distribution (df = 19)
## - Fisher's z transformation of correlations
```

Secondary meta-analysis forest plots

Forest plot for secondary analysis with Pearson r correlation coefficients

```r
forest(m.rho,
       xlim = c(-1.0, 0.6),
       prediction = TRUE,
       layout = "Revman")
```



Save plot:

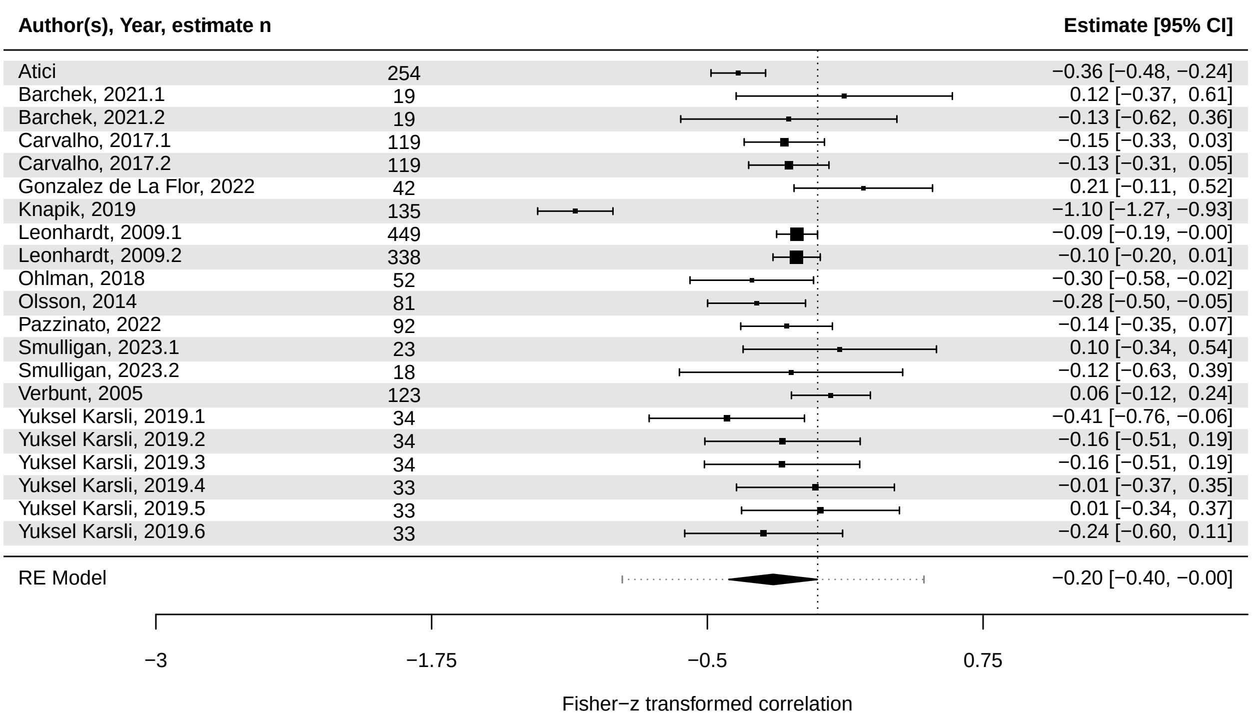
```r
png(file = "Secondary analysis forest plot with meta.png",
    width = 2800, height = 2500, res = 300)

forest(m.rho,
       xlim = c(-1.0, 0.6),
```

```r
        layout = "Revman")

dev.off()
```

```
## pdf
##   2
```

Forest plot for secondary analysis with Fisher z using metafor

```r
forest(m.cor.rho,
       cex=0.8,
       addpred=TRUE,
       alim=c(-3,2),
       xlab = "Fisher-z transformed correlation",
       ilab = n,
       header="Author(s), Year, estimate n",
       shade= "zebra")
text(c(-2.77), m.cor.rho$k+2, c("n"), cex=0.75, font=2)
```



Save plot:

```r
png(file = "Rho analysis forestplot.png",
    width = 3000, height = 2600, res = 300)

forest(m.cor.rho,
       cex=0.8,
       addpred=TRUE,
       alim=c(-3,2),
       xlab = "Fisher-z transformed correlation",
       ilab = n,
       header="Author(s), Year, estimate n",
       shade= "zebra")
```

```r
text(c(-2.77), m.cor.rho$k+2, c("n"), cex=0.75, font=2)

dev.off()
```

```
## pdf
##   2
```

Meta-analysis: subgroup analyses

Subgroup analysis by health status

```r
Kinphob_r$Health_status <- as.factor(Kinphob_r$Health_status)


Health_subg <- rma.mv(yi = z,
                      V = var.z,
                      slab = author,
                      data = Kinphob_r,
                      random = ~ 1 | author/cor_id,
                      test = "t",
                      method = "REML",
                      mods = ~ Health_status)

summary(Health_subg)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
##   1.1209   -2.2418   27.7582   61.4857   36.6471
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0403  0.2008     63     no         author
## sigma^2.2  0.0044  0.0662     83     no  author/cor_id
##
## Test for Residual Heterogeneity:
## QE(df = 70) = 360.5491, p-val < .0001
##
## Test of Moderators (coefficients 2:13):
## F(df1 = 12, df2 = 70) = 3.1070, p-val = 0.0014
##
## Model Results:
##
##                                        estimate      se     tval  df    pval
## intrcpt                                 -0.1290  0.1807  -0.7137  70  0.4778
## Health_statusArthritis                  -0.1295  0.1967  -0.6582  70  0.5126
## Health_statusCancer                      0.0448  0.2821   0.1587  70  0.8743
## Health_statusCardiovascular condition   -0.1813  0.2058  -0.8810  70  0.3813
## Health_statusChronic pain                0.0549  0.1860   0.2953  70  0.7687
## Health_statusFibromyalgia                0.0735  0.2869   0.2563  70  0.7985
## Health_statusNeurological condition     -0.4570  0.2214  -2.0643  70  0.0427
```

```
## Health_statusObstructive Sleep Apnea    -0.0545  0.2869  -0.1899  70  0.8499
## Health_statusOlder adults              -0.2919  0.2274  -1.2836  70  0.2035
## Health_statusPost-Partum Women         -0.0018  0.2911  -0.0060  70  0.9952
## Health_statusPulmonary condition       -0.7035  0.2450  -2.8710  70  0.0054
## Health_statusSurgery                   -0.0339  0.2097  -0.1617  70  0.8720
## Health_statusYoung adults               0.1220  0.2959   0.4122  70  0.6814
##                                         ci.lb    ci.ub
## intrcpt                                -0.4894   0.2315
## Health_statusArthritis                 -0.5218   0.2628
## Health_statusCancer                    -0.5179   0.6075
## Health_statusCardiovascular condition  -0.5919   0.2292
## Health_statusChronic pain              -0.3160   0.4258
## Health_statusFibromyalgia              -0.4987   0.6457
## Health_statusNeurological condition    -0.8985  -0.0155   *
## Health_statusObstructive Sleep Apnea   -0.6267   0.5177
## Health_statusOlder adults              -0.7454   0.1616
## Health_statusPost-Partum Women         -0.5823   0.5787
## Health_statusPulmonary condition       -1.1922  -0.2148  **
## Health_statusSurgery                   -0.4522   0.3844
## Health_statusYoung adults              -0.4682   0.7122
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The Test of Moderators revealed a significant difference between subgroups, $F_{12,70} = 3.107$, with $p = 0.0014$.

Note that the model results are printed within a meta-regression framework. This means that we cannot directly extract the estimates in order to obtain the pooled effect sizes within subgroups. The first value, the intercept (intrcpt), shows the z value when the health status was acute pain (z = -0.129). The effect in the other groups can be obtained by adding their estimate to the one of the intercept. Thus, the effect in the arthritis group is z = -0.1290 - 0.1295 = -0.258, and the one in the Cancer group is z = -0.1290 + 0.0448 = -0.0838. The same is true for the upper and lower confidence intervals.These are also Fisher z scores.

```r
Health_stat_meta <- update(m, subgroup = Health_status, tau.common = TRUE)
Health_stat_meta
```

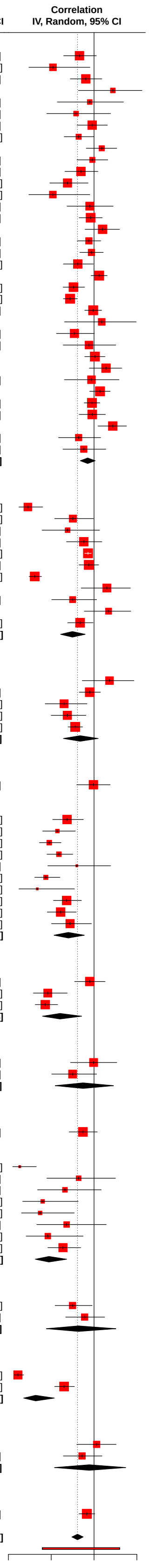
```
## Review:     Primary meta-analysis using metacor
##
## Number of studies: n = 63
## Number of estimates: k = 83
## Number of observations: o = 12278
##
##                            COR             95%-CI     t  p-value
## Random effects model -0.1931 [-0.2579; -0.1266] -5.70 < 0.0001
## Prediction interval          [-0.6051;  0.3004]
##
## Quantifying heterogeneity:
##  tau^2.1 = 0.0576 [0.0227; 0.0950]; tau.1 = 0.2399 [0.1508; 0.3082] (between cluster)
##  tau^2.2 = 0.0058 [0.0000; 0.0398]; tau.2 = 0.0762 [0.0000; 0.1995] (within cluster)
##  I^2 = 85.5% [82.6%; 87.9%]; H = 2.62 [2.40; 2.87]
##
## Quantifying residual heterogeneity:
##  tau^2 = 0.0392; tau = 0.1980; I^2 = 80.6%; H = 2.27
##
## Test of heterogeneity:
##       Q d.f.  p-value
```

```
##  564.77   82 < 0.0001
##
## Results for subgroups (random effects model):
##                                          k     COR             95%-CI  tau^2
## Health_status = Chronic pain            35 -0.0739 [-0.1600;  0.0132] 0.0447
## Health_status = Arthritis               11 -0.2529 [-0.3913; -0.1032] 0.0447
## Health_status = Surgery                  5 -0.1615 [-0.3585;  0.0494] 0.0447
## Health_status = Young adults             1 -0.0070 [-0.4417;  0.4303] 0.0447
## Health_status = Cardiovascular condition  10 -0.3007 [-0.4674; -0.1134] 0.0447
## Health_status = Older adults             3 -0.3977 [-0.6019; -0.1446] 0.0447
## Health_status = Acute pain               2 -0.1283 [-0.4538;  0.2274] 0.0447
## Health_status = Post-Partum Women        1 -0.1300 [-0.5268;  0.3134] 0.0447
## Health_status = Neurological condition   8 -0.5270 [-0.6863; -0.3194] 0.0447
## Health_status = Obstructive Sleep Apnea  2 -0.1814 [-0.5566;  0.2552] 0.0447
## Health_status = Pulmonary condition      2 -0.6818 [-0.8218; -0.4641] 0.0447
## Health_status = Fibromyalgia             2 -0.0554 [-0.4620;  0.3704] 0.0447
## Health_status = Cancer                   1 -0.0840 [-0.4748;  0.3345] 0.0447
##                                           tau      Q   I^2
## Health_status = Chronic pain            0.2114  90.07 62.3%
## Health_status = Arthritis               0.2114 151.57 93.4%
## Health_status = Surgery                 0.2114  13.07 69.4%
## Health_status = Young adults            0.2114   0.00    --
## Health_status = Cardiovascular condition 0.2114  12.63 28.7%
## Health_status = Older adults            0.2114  22.61 91.2%
## Health_status = Acute pain              0.2114   1.52 34.2%
## Health_status = Post-Partum Women       0.2114   0.00    --
## Health_status = Neurological condition  0.2114  15.86 55.9%
## Health_status = Obstructive Sleep Apnea 0.2114   0.75  0.0%
## Health_status = Pulmonary condition     0.2114  51.46 98.1%
## Health_status = Fibromyalgia            0.2114   1.02  2.2%
## Health_status = Cancer                  0.2114   0.00    --
##
## Test for subgroup differences (random effects model):
##                    F   d.f. p-value
## Between groups 3.11 12, 70  0.0014
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
##   (assuming common tau^2 in subgroups)
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 82)
## - Prediction interval based on t-distribution (df = 81)
## - Fisher's z transformation of correlations
```

The test of subgroup differences between health status was conducted on studies comprising people with chronic (k = 35) or acute pain (k = 2), arthritis (k = 11), a cardiovascular condition (k = 10), a neurological condition (k = 8), surgery (k = 5), older age (k = 3), obstructive sleep apnea (k = 2), a pulmonary condition (k = 2), fibromyalgia (k = 2), cancer (k = 1), as well as in post-partum women (k = 1) and healthy young adults (k = 1). We found a statistical moderating effect of health status (p = 0.0014). The relationship between kinesiophobia and physical activity was statistically significant only in studies that included participants with cardiac condition (r = -0.30; 95CI: -0.47 to -0.11), arthritis (r = -0.25; 95CI: -0.39 to -0.10), a neurologic condition (r = -0.53; 95CI: -0.69 to -0.32), a pulmonary condition (r = -0.68; 95CI: -0.82 to -0.46), or older adults (r = -0.40; 95CI: -0.60 to -0.14). We found no evidence of an association between kinesiophobia and physical activity in studies that included participants with chronic pain (r = -0.07; 95CI: -0.16 to 0.01) or acute pain (r = -0.13; 95CI: -0.45 to 0.23). Statistical heterogeneity was higher in the studies comprising people with a pulmonary condition (I2 = 98.1%), arthritis (I2 = 93.4%), or older adults (I2 = 91.2%) than in the studies comprising people with a cardiac (I2 = 28.7%) or neurologic condition (I2 = 55.9%).

```r
forest(Health_stat_meta,
       layout = "Revman5",
       common = FALSE,
       xlim = c(-1.0, 0.6),
       prediction = TRUE,
       fs.hetstat = 10,
       col.subgroup = "black",
       addrows.below.overall = 2)
```

Study or Subgroup	Cluster	Total	Weight	Correlation IV, Random, 95% CI
Health_status = Chronic pain				
Alamam, 2019	sample_1	100	1.6%	−0.17 [−0.35; 0.03]
Alschuler, 2011	sample_2	20	1.0%	−0.48 [−0.76; −0.05]
Altug, 2016	sample_3	112	1.6%	−0.10 [−0.28; 0.09]
Alzahrani, 2021	sample_4	26	0.5%	0.22 [−0.18; 0.56]
Alzahrani, 2021	sample_4	26	0.5%	−0.05 [−0.43; 0.34]
Alzahrani, 2021	sample_4	26	0.5%	−0.21 [−0.55; 0.19]
Assadourian, 2020	sample_5	123	1.6%	−0.02 [−0.20; 0.16]
Carvalho, 2017	sample_13	119	0.6%	−0.18 [−0.35; −0.00]
Carvalho, 2017	sample_13	119	0.6%	0.09 [−0.09; 0.27]
Carvalho, 2017	sample_13	119	0.6%	−0.02 [−0.20; 0.16]
Demirbuken, 2016	sample_18	99	1.6%	−0.15 [−0.34; 0.05]
Elfving, 2007	sample_22	64	1.5%	−0.31 [−0.52; −0.07]
Glaviano, 2017	sample_23	20	1.0%	−0.48 [−0.76; −0.05]
Helmus, 2012	sample_24	53	1.4%	−0.05 [−0.32; 0.22]
Ho−A−Tham, 2022	sample_25	210	1.7%	−0.04 [−0.17; 0.10]
Koho, 2011	sample_28	93	1.6%	0.10 [−0.11; 0.30]
Koppenaal, 2023	sample_29	204	0.9%	−0.06 [−0.20; 0.08]
Koppenaal, 2023	sample_29	204	0.9%	−0.03 [−0.17; 0.11]
Lotzke, 2018	sample_30	118	1.6%	−0.19 [−0.36; −0.01]
Luthi, 2022	sample_31	433	1.8%	0.06 [−0.03; 0.15]
Marshall, 2017	sample_33	218	1.7%	−0.24 [−0.36; −0.11]
Marshall, 2021	sample_34	508	1.8%	−0.28 [−0.36; −0.20]
Marshall, 2022	sample_35	393	1.8%	−0.01 [−0.11; 0.09]
Masse−Alarie, 2016	sample_36	22	1.0%	0.09 [−0.34; 0.49]
Minetama, 2022	sample_38	71	1.5%	−0.23 [−0.44; 0.00]
Navarro−Ledesma, 2022	sample_39	41	1.3%	−0.06 [−0.36; 0.25]
Pastor−Mira, 2020	sample_44	274	1.8%	0.01 [−0.11; 0.13]
Pedler, 2018	sample_45	103	1.6%	0.14 [−0.06; 0.32]
Polaski, 2021	sample_47	38	1.3%	−0.03 [−0.35; 0.29]
Rabey, 2017	sample_49	266	1.8%	0.07 [−0.05; 0.19]
Sandal, 2021	sample_51	460	1.8%	−0.02 [−0.12; 0.07]
Sertel, 2021	sample_53	163	1.7%	−0.02 [−0.17; 0.13]
Suttmiller, 2022	sample_58	126	1.6%	0.22 [0.05; 0.38]
Zadro, 2019	sample_62	60	0.9%	−0.18 [−0.41; 0.08]
Zadro, 2019	sample_62	60	0.9%	−0.12 [−0.36; 0.14]
Total (95% CI)		**5091**	**45.8%**	**−0.07 [−0.16; 0.01]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 90.07$, df = 34 ($P < 0.01$); $I^2 = 62\%$				
Health_status = Arthritis				
Aydemir, 2022	sample_6	37	1.3%	−0.77 [−0.88; −0.60]
Aykut Selcuk, 2020	sample_7	67	1.1%	−0.25 [−0.46; −0.01]
Aykut Selcuk, 2020	sample_7	29	0.5%	−0.31 [−0.61; 0.06]
Baday−Keskin, 2022	sample_8	88	1.6%	−0.12 [−0.32; 0.09]
Demmelmaier, 2018	sample_19	2569	1.8%	−0.07 [−0.11; −0.03]
Dogan, 2022	sample_20	290	1.8%	−0.06 [−0.17; 0.05]
Kilinc, 2019	sample_27	200	1.7%	−0.69 [−0.76; −0.61]
Ozlu, 2022	sample_42	45	1.4%	0.15 [−0.15; 0.42]
Peres, 2023	sample_46	50	0.8%	−0.25 [−0.49; 0.03]
Peres, 2023	sample_46	50	0.8%	0.17 [−0.11; 0.43]
Uritani, 2020	sample_59	167	1.7%	−0.16 [−0.31; −0.01]
Total (95% CI)		**3592**	**14.5%**	**−0.25 [−0.39; −0.10]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 151.57$, df = 10 ($P < 0.01$); $I^2 = 93\%$				
Health_status = Surgery				
Baez, 2020	sample_9	40	1.3%	0.18 [−0.14; 0.47]
Coronado, 2021	sample_14	248	1.7%	−0.05 [−0.17; 0.08]
Donnarumma, 2017	sample_21	51	1.4%	−0.35 [−0.57; −0.08]
Norte, 2019	sample_40	77	1.5%	−0.31 [−0.50; −0.09]
Zelle, 2016	sample_63	487	1.8%	−0.22 [−0.30; −0.13]
Total (95% CI)		**903**	**7.8%**	**−0.16 [−0.36; 0.05]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 13.07$, df = 4 ($P = 0.01$); $I^2 = 69\%$				
Health_status = Young adults				
Bahar Ozdemir, 2021	sample_10	101	1.6%	−0.01 [−0.20; 0.19]
Health_status = Cardiovascular condition				
Baykal Sahin, 2021	sample_11	98	1.6%	−0.32 [−0.48; −0.12]
Dabek, 2020	sample_17	72	0.3%	−0.43 [−0.60; −0.22]
Dabek, 2020	sample_17	130	0.5%	−0.52 [−0.64; −0.39]
Dabek, 2020	sample_17	119	0.5%	−0.41 [−0.55; −0.25]
Dabek, 2020	sample_17	27	0.1%	−0.20 [−0.54; 0.19]
Dabek, 2020	sample_17	86	0.4%	−0.56 [−0.69; −0.40]
Dabek, 2020	sample_17	15	0.1%	−0.66 [−0.88; −0.23]
Marques−Sule, 2022	sample_32	117	1.6%	−0.32 [−0.47; −0.15]
Roaldsen, 2009	sample_50	98	1.6%	−0.39 [−0.55; −0.21]
Spaderna, 2020	sample_55	61	1.5%	−0.28 [−0.50; −0.03]
Total (95% CI)		**823**	**8.1%**	**−0.30 [−0.47; −0.11]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 12.63$, df = 9 ($P = 0.18$); $I^2 = 29\%$				
Health_status = Older adults				
Bernard, 2015	sample_12	121	1.6%	−0.05 [−0.23; 0.13]
Miller, 2018	sample_37	52	1.4%	−0.54 [−0.71; −0.31]
Saulicz, 2016	sample_52	105	1.6%	−0.57 [−0.69; −0.42]
Total (95% CI)		**278**	**4.7%**	**−0.40 [−0.60; −0.14]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 22.61$, df = 2 ($P < 0.01$); $I^2 = 91\%$				
Health_status = Acute pain				
Corrigan, 2018	sample_15	53	1.4%	−0.00 [−0.27; 0.27]
Priore, 2020	sample_48	50	1.4%	−0.25 [−0.49; 0.03]
Total (95% CI)		**103**	**2.8%**	**−0.13 [−0.45; 0.23]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 1.52$, df = 1 ($P = 0.22$); $I^2 = 34\%$				
Health_status = Post−Partum Women				
Cromert, 2021	sample_16	139	1.7%	−0.13 [−0.29; 0.04]
Health_status = Neurological condition				
Dabek, 2020	sample_17	18	0.1%	−0.87 [−0.95; −0.67]
Smulligan, 2023	sample_54	23	0.5%	−0.18 [−0.55; 0.25]
Smulligan, 2023	sample_54	23	0.5%	−0.34 [−0.66; 0.08]
Smulligan, 2023	sample_54	18	0.3%	−0.60 [−0.83; −0.18]
Smulligan, 2023	sample_54	18	0.3%	−0.63 [−0.85; −0.23]
Sutcu, 2021	sample_57	20	0.7%	−0.32 [−0.67; 0.14]
Sutcu, 2021	sample_57	20	0.7%	−0.54 [−0.79; −0.13]
Wasiuk−Zowada, 2022	sample_61	80	1.5%	−0.36 [−0.54; −0.16]
Total (95% CI)		**220**	**4.6%**	**−0.53 [−0.69; −0.32]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 15.86$, df = 7 ($P = 0.03$); $I^2 = 56\%$				
Health_status = Obstructive Sleep Apnea				
Igelstrom, 2013	sample_26	73	0.9%	−0.25 [−0.45; −0.02]
Igelstrom, 2013	sample_26	73	0.9%	−0.11 [−0.33; 0.12]
Total (95% CI)		**146**	**1.7%**	**−0.18 [−0.56; 0.26]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 0.75$, df = 1 ($P = 0.39$); $I^2 = 0\%$				
Health_status = Pulmonary condition				
Ozer, 2022	sample_41	62	1.5%	−0.89 [−0.93; −0.82]
Wang , 2023	sample_60	223	1.7%	−0.35 [−0.46; −0.23]
Total (95% CI)		**285**	**3.2%**	**−0.68 [−0.82; −0.46]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 51.46$, df = 1 ($P < 0.01$); $I^2 = 98\%$				
Health_status = Fibromyalgia				
Palstam, 2014	sample_43	73	0.9%	0.03 [−0.20; 0.26]
Palstam, 2014	sample_43	73	0.9%	−0.14 [−0.36; 0.09]
Total (95% CI)		**146**	**1.7%**	**−0.06 [−0.46; 0.37]**
Heterogeneity: $Tau^2 = 0.0447$; $Chi^2 = 1.02$, df = 1 ($P = 0.31$); $I^2 = 2\%$				
Health_status = Cancer				
Strandberg, 2022	sample_56	451	1.8%	−0.08 [−0.17; 0.01]
Total (95% CI)		**12278**	**100.0%**	**−0.19 [−0.26; −0.13]**
Prediction interval				**[−0.61; 0.30]**



Heterogeneity: $Tau^2 = 0.0634$; $Chi^2 = 564.77$, df = 82 ($P < 0.01$); $I^2 = 85\%$
Residual heterogeneity: $Tau^2 = 0.0392$; $Chi^2 = 360.55$, df = 70 ($P < 0.01$); $I^2 = 81\%$
Test for subgroup differences: $F = 3.11$, df = 12, 70 ($P < 0.01$)

```r
png(file = "Health condition forest plot.png",
    width = 2800, height = 7800, res = 300)

forest(Health_stat_meta,
       layout = "Revman5",
       sortvar = -TE,
       common = FALSE,
       xlim = c(-1.0, 0.6),
       prediction = TRUE,
       fs.hetstat = 10,
       col.subgroup = "black",
       addrows.below.overall = 2)

dev.off()
```

```
## pdf
##   2
```

Subgroup analysis by physical activity measure: device vs self-report

```r
Kinphob_r$PA_objectivity <- as.factor(Kinphob_r$PA_objectivity)

PAobj_subg <- rma.mv(yi = z,
                     V = var.z,
                     slab = author,
                     data = Kinphob_r,
                     random = ~ 1 | author/cor_id,
                     test = "t",
                     method = "REML",
                     mods = ~ PA_objectivity)

summary(PAobj_subg)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
## -10.7304   21.4608   29.4608   39.0386   29.9871
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0623  0.2495     63     no         author
## sigma^2.2  0.0015  0.0392     83     no  author/cor_id
##
## Test for Residual Heterogeneity:
## QE(df = 81) = 558.5318, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 81) = 1.9042, p-val = 0.1714
##
## Model Results:
##
##                                       estimate      se     tval  df    pval
```

```
## intrcpt                              -0.1323  0.0573  -2.3106  81  0.0234
## PA_objectivitySelf-reported measure   -0.0896  0.0649  -1.3799  81  0.1714
##                                        ci.lb    ci.ub
## intrcpt                              -0.2462  -0.0184  *
## PA_objectivitySelf-reported measure  -0.2188   0.0396
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The effect the objective measures group is z = -0.132, and in the self-report group it is z = -0.132 - .090 = -0.222.

```
PAobj_meta <- update(m, subgroup = PA_objectivity, tau.common = TRUE)
PAobj_meta
```

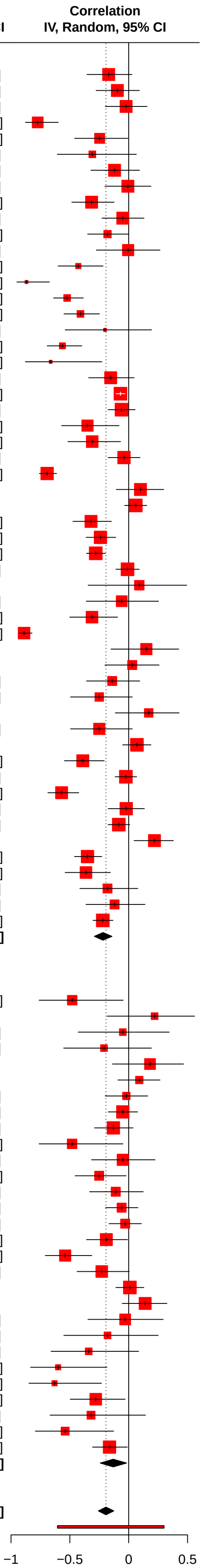
```
## Review:     Primary meta-analysis using metacor
##
## Number of studies: n = 63
## Number of estimates: k = 83
## Number of observations: o = 12278
##
##                           COR            95%-CI     t  p-value
## Random effects model -0.1931 [-0.2579; -0.1266] -5.70 < 0.0001
## Prediction interval          [-0.6051;  0.3004]
##
## Quantifying heterogeneity:
##  tau^2.1 = 0.0576 [0.0227; 0.0950]; tau.1 = 0.2399 [0.1508; 0.3082] (between cluster)
##  tau^2.2 = 0.0058 [0.0000; 0.0398]; tau.2 = 0.0762 [0.0000; 0.1995] (within cluster)
##  I^2 = 85.5% [82.6%; 87.9%]; H = 2.62 [2.40; 2.87]
##
## Quantifying residual heterogeneity:
##  tau^2 = 0.0656; tau = 0.2560; I^2 = 85.5%; H = 2.63
##
## Test of heterogeneity:
##       Q d.f.  p-value
##  564.77   82 < 0.0001
##
## Results for subgroups (random effects model):
##                                          k     COR            95%-CI  tau^2
## PA_objectivity = Self-reported measure  54 -0.2183 [-0.2919; -0.1422] 0.0638
## PA_objectivity = Device-based measure   29 -0.1315 [-0.2414; -0.0184] 0.0638
##                                           tau      Q   I^2
## PA_objectivity = Self-reported measure 0.2526 493.17 89.3%
## PA_objectivity = Device-based measure  0.2526  65.36 57.2%
##
## Test for subgroup differences (random effects model):
##                    F  d.f. p-value
## Between groups 1.90 1, 81  0.1714
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
##   (assuming common tau^2 in subgroups)
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 82)
```

```
## - Prediction interval based on t-distribution (df = 81)
## - Fisher's z transformation of correlations
```

The test of subgroup differences between self-reported (k = 54) and device-based (k = 29) measures of physical activity showed no evidence of a moderating effect of the type of physical activity measure (p = 0.171). Both self-reported measures (r = -0.22; 95CI: -0.29 to -0.14; I2 = 89.3%) and device-based measures (r = -0.13; 95CI: -0.24 to -0.02; I2 = 57.2%) showed a negative association between kinesiophobia and physical activity.

```r
forest(PAobj_meta,
            layout = "RevMan5",
            common = FALSE,
            xlim = c(-1.0, 0.6),
            prediction = TRUE,
            fs.hetstat = 10,
            col.subgroup = "black",
            addrows.below.overall = 2)
```

Study or Subgroup	Cluster	Total	Weight	Correlation IV, Random, 95% CI
PA_objectivity = Self−reported measure				
Alamam, 2019	sample_1	100	1.6%	−0.17 [−0.35; 0.03]
Altug, 2016	sample_3	112	1.6%	−0.10 [−0.28; 0.09]
Assadourian, 2020	sample_5	123	1.6%	−0.02 [−0.20; 0.16]
Aydemir, 2022	sample_6	37	1.3%	−0.77 [−0.88; −0.60]
Aykut Selcuk, 2020	sample_7	67	1.1%	−0.25 [−0.46; −0.01]
Aykut Selcuk, 2020	sample_7	29	0.5%	−0.31 [−0.61; 0.06]
Baday−Keskin, 2022	sample_8	88	1.6%	−0.12 [−0.32; 0.09]
Bahar Ozdemir, 2021	sample_10	101	1.6%	−0.01 [−0.20; 0.19]
Baykal Sahin, 2021	sample_11	98	1.6%	−0.32 [−0.48; −0.12]
Bernard, 2015	sample_12	121	1.6%	−0.05 [−0.23; 0.13]
Carvalho, 2017	sample_13	119	0.6%	−0.18 [−0.35; −0.00]
Corrigan, 2018	sample_15	53	1.4%	−0.00 [−0.27; 0.27]
Dabek, 2020	sample_17	72	0.3%	−0.43 [−0.60; −0.22]
Dabek, 2020	sample_17	18	0.1%	−0.87 [−0.95; −0.67]
Dabek, 2020	sample_17	130	0.5%	−0.52 [−0.64; −0.39]
Dabek, 2020	sample_17	119	0.5%	−0.41 [−0.55; −0.25]
Dabek, 2020	sample_17	27	0.1%	−0.20 [−0.54; 0.19]
Dabek, 2020	sample_17	86	0.4%	−0.56 [−0.69; −0.40]
Dabek, 2020	sample_17	15	0.1%	−0.66 [−0.88; −0.23]
Demirbuken, 2016	sample_18	99	1.6%	−0.15 [−0.34; 0.05]
Demmelmaier, 2018	sample_19	2569	1.8%	−0.07 [−0.11; −0.03]
Dogan, 2022	sample_20	290	1.8%	−0.06 [−0.17; 0.05]
Donnarumma, 2017	sample_21	51	1.4%	−0.35 [−0.57; −0.08]
Elfving, 2007	sample_22	64	1.5%	−0.31 [−0.52; −0.07]
Ho−A−Tham, 2022	sample_25	210	1.7%	−0.04 [−0.17; 0.10]
Kilinc, 2019	sample_27	200	1.7%	−0.69 [−0.76; −0.61]
Koho, 2011	sample_28	93	1.6%	0.10 [−0.11; 0.30]
Luthi, 2022	sample_31	433	1.8%	0.06 [−0.03; 0.15]
Marques−Sule, 2022	sample_32	117	1.6%	−0.32 [−0.47; −0.15]
Marshall, 2017	sample_33	218	1.7%	−0.24 [−0.36; −0.11]
Marshall, 2021	sample_34	508	1.8%	−0.28 [−0.36; −0.20]
Marshall, 2022	sample_35	393	1.8%	−0.01 [−0.11; 0.09]
Masse−Alarie, 2016	sample_36	22	1.0%	0.09 [−0.34; 0.49]
Navarro−Ledesma, 2022	sample_39	41	1.3%	−0.06 [−0.36; 0.25]
Norte, 2019	sample_40	77	1.5%	−0.31 [−0.50; −0.09]
Ozer, 2022	sample_41	62	1.5%	−0.89 [−0.93; −0.82]
Ozlu, 2022	sample_42	45	1.4%	0.15 [−0.15; 0.42]
Palstam, 2014	sample_43	73	0.9%	0.03 [−0.20; 0.26]
Palstam, 2014	sample_43	73	0.9%	−0.14 [−0.36; 0.09]
Peres, 2023	sample_46	50	0.8%	−0.25 [−0.49; 0.03]
Peres, 2023	sample_46	50	0.8%	0.17 [−0.11; 0.43]
Priore, 2020	sample_48	50	1.4%	−0.25 [−0.49; 0.03]
Rabey, 2017	sample_49	266	1.8%	0.07 [−0.05; 0.19]
Roaldsen, 2009	sample_50	98	1.6%	−0.39 [−0.55; −0.21]
Sandal, 2021	sample_51	460	1.8%	−0.02 [−0.12; 0.07]
Saulicz, 2016	sample_52	105	1.6%	−0.57 [−0.69; −0.42]
Sertel, 2021	sample_53	163	1.7%	−0.02 [−0.17; 0.13]
Strandberg, 2022	sample_56	451	1.8%	−0.08 [−0.17; 0.01]
Suttmiller, 2022	sample_58	126	1.6%	0.22 [0.05; 0.38]
Wang , 2023	sample_60	223	1.7%	−0.35 [−0.46; −0.23]
Wasiuk−Zowada, 2022	sample_61	80	1.5%	−0.36 [−0.54; −0.16]
Zadro, 2019	sample_62	60	0.9%	−0.18 [−0.41; 0.08]
Zadro, 2019	sample_62	60	0.9%	−0.12 [−0.36; 0.14]
Zelle, 2016	sample_63	487	1.8%	−0.22 [−0.30; −0.13]
Total (95% CI)		**9882**	**70.2%**	**−0.22 [−0.29; −0.14]**
Heterogeneity: $Tau^2 = 0.0638$; $Chi^2 = 493.17$, df = 53 ($P < 0.01$); $I^2 = 89\%$				
PA_objectivity = Device−based measure				
Alschuler, 2011	sample_2	20	1.0%	−0.48 [−0.76; −0.05]
Alzahrani, 2021	sample_4	26	0.5%	0.22 [−0.18; 0.56]
Alzahrani, 2021	sample_4	26	0.5%	−0.05 [−0.43; 0.34]
Alzahrani, 2021	sample_4	26	0.5%	−0.21 [−0.55; 0.19]
Baez, 2020	sample_9	40	1.3%	0.18 [−0.14; 0.47]
Carvalho, 2017	sample_13	119	0.6%	0.09 [−0.09; 0.27]
Carvalho, 2017	sample_13	119	0.6%	−0.02 [−0.20; 0.16]
Coronado, 2021	sample_14	248	1.7%	−0.05 [−0.17; 0.08]
Cromert, 2021	sample_16	139	1.7%	−0.13 [−0.29; 0.04]
Glaviano, 2017	sample_23	20	1.0%	−0.48 [−0.76; −0.05]
Helmus, 2012	sample_24	53	1.4%	−0.05 [−0.32; 0.22]
Igelstrom, 2013	sample_26	73	0.9%	−0.25 [−0.45; −0.02]
Igelstrom, 2013	sample_26	73	0.9%	−0.11 [−0.33; 0.12]
Koppenaal, 2023	sample_29	204	0.9%	−0.06 [−0.20; 0.08]
Koppenaal, 2023	sample_29	204	0.9%	−0.03 [−0.17; 0.11]
Lotzke, 2018	sample_30	118	1.6%	−0.19 [−0.36; −0.01]
Miller, 2018	sample_37	52	1.4%	−0.54 [−0.71; −0.31]
Minetama, 2022	sample_38	71	1.5%	−0.23 [−0.44; 0.00]
Pastor−Mira, 2020	sample_44	274	1.8%	0.01 [−0.11; 0.13]
Pedler, 2018	sample_45	103	1.6%	0.14 [−0.06; 0.32]
Polaski, 2021	sample_47	38	1.3%	−0.03 [−0.35; 0.29]
Smulligan, 2023	sample_54	23	0.5%	−0.18 [−0.55; 0.25]
Smulligan, 2023	sample_54	23	0.5%	−0.34 [−0.66; 0.08]
Smulligan, 2023	sample_54	18	0.3%	−0.60 [−0.83; −0.18]
Smulligan, 2023	sample_54	18	0.3%	−0.63 [−0.85; −0.23]
Spaderna, 2020	sample_55	61	1.5%	−0.28 [−0.50; −0.03]
Sutcu, 2021	sample_57	20	0.7%	−0.32 [−0.67; 0.14]
Sutcu, 2021	sample_57	20	0.7%	−0.54 [−0.79; −0.13]
Uritani, 2020	sample_59	167	1.7%	−0.16 [−0.31; −0.01]
Total (95% CI)		**2396**	**29.8%**	**−0.13 [−0.24; −0.02]**
Heterogeneity: $Tau^2 = 0.0638$; $Chi^2 = 65.36$, df = 28 ($P < 0.01$); $I^2 = 57\%$				
Total (95% CI)		**12278**	**100.0%**	**−0.19 [−0.26; −0.13]**
Prediction interval				**[−0.61; 0.30]**



Heterogeneity: $Tau^2 = 0.0634$; $Chi^2 = 564.77$, df = 82 ($P < 0.01$); $I^2 = 85\%$
Residual heterogeneity: $Tau^2 = 0.0656$; $Chi^2 = 558.53$, df = 81 ($P < 0.01$); $I^2 = 85\%$
Test for subgroup differences: $F = 1.90$, df = 1, 81 ($P = 0.17$)

```r
png(file = "PA objectivity forestplot.png",
    width = 2800, height = 5800, res = 300)

forest(PAobj_meta,
            layout = "RevMan5",
            common = FALSE,
            xlim = c(-1.0, 0.6),
            prediction = TRUE,
            fs.hetstat = 10,
            col.subgroup = "black",
            addrows.below.overall = 2)

dev.off()
```

```
## pdf
##   2
```

Subgroup analysis by physical activity measurement instruments

```r
Kinphob_r$PA_measure <- as.factor(Kinphob_r$PA_measure)

PAmeas_subg <- rma.mv(yi = z,
                      V = var.z,
                      slab = author,
                      data = Kinphob_r,
                      random = ~ 1 | author/cor_id,
                      test = "t",
                      method = "REML",
                      mods = ~ PA_measure)

summary(PAmeas_subg)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
##  -6.4184   12.8369   48.8369   88.5213   63.0869
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0626  0.2503     63     no         author
## sigma^2.2  0.0000  0.0000     83     no  author/cor_id
##
## Test for Residual Heterogeneity:
## QE(df = 67) = 490.8621, p-val < .0001
##
## Test of Moderators (coefficients 2:16):
## F(df1 = 15, df2 = 67) = 1.3310, p-val = 0.2092
##
## Model Results:
##
##                            estimate      se     tval  df    pval    ci.lb
## intrcpt                     -0.1711  0.0624  -2.7416  67  0.0078  -0.2957
```

```
## PA_measureBHPAQ           -0.1803  0.0940  -1.9184  67  0.0593  -0.3678
## PA_measureDiary            0.1491  0.2736   0.5449  67  0.5876  -0.3970
## PA_measureGLTEQ           -0.0300  0.2120  -0.1417  67  0.8877  -0.4531
## PA_measureGPAQ             0.1792  0.2155   0.8313  67  0.4087  -0.2510
## PA_measureIPAQ            -0.1151  0.0890  -1.2934  67  0.2003  -0.2926
## PA_measureJPAS             0.3937  0.2732   1.4409  67  0.1543  -0.1517
## PA_measureLTPAI            0.1156  0.2714   0.4261  67  0.6714  -0.4261
## PA_measureMLTPAQ           0.0989  0.1959   0.5048  67  0.6154  -0.2921
## PA_measurePASE             0.1501  0.2698   0.5564  67  0.5798  -0.3884
## PA_measurePedometer        0.1501  0.1716   0.8749  67  0.3847  -0.1923
## PA_measureQuestionnaire    0.0213  0.1437   0.1485  67  0.8824  -0.2654
## PA_measureRAPAQ            0.0198  0.2744   0.0722  67  0.9426  -0.5279
## PA_measureSGPALS          -0.0167  0.1499  -0.1117  67  0.9114  -0.3159
## PA_measureSQUASH           0.1292  0.2778   0.4652  67  0.6433  -0.4253
## PA_measureUCLA            -0.8566  0.3097  -2.7656  67  0.0073  -1.4749
##                            ci.ub
## intrcpt                  -0.0465  **
## PA_measureBHPAQ           0.0073   .
## PA_measureDiary           0.6952
## PA_measureGLTEQ           0.3930
## PA_measureGPAQ            0.6094
## PA_measureIPAQ            0.0625
## PA_measureJPAS            0.9391
## PA_measureLTPAI           0.6574
## PA_measureMLTPAQ          0.4898
## PA_measurePASE            0.6886
## PA_measurePedometer       0.4925
## PA_measureQuestionnaire   0.3081
## PA_measureRAPAQ           0.5676
## PA_measureSGPALS          0.2824
## PA_measureSQUASH          0.6837
## PA_measureUCLA           -0.2384  **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
PAm <- update(m,
       subgroup = PA_measure,
       tau.common = TRUE)
PAm
```

```
## Review:     Primary meta-analysis using metacor
##
## Number of studies: n = 63
## Number of estimates: k = 83
## Number of observations: o = 12278
##
##                          COR             95%-CI     t  p-value
## Random effects model -0.1931 [-0.2579; -0.1266] -5.70 < 0.0001
## Prediction interval          [-0.6051;  0.3004]
##
## Quantifying heterogeneity:
##  tau^2.1 = 0.0576 [0.0227; 0.0950]; tau.1 = 0.2399 [0.1508; 0.3082] (between cluster)
##  tau^2.2 = 0.0058 [0.0000; 0.0398]; tau.2 = 0.0762 [0.0000; 0.1995] (within cluster)
##  I^2 = 85.5% [82.6%; 87.9%]; H = 2.62 [2.40; 2.87]
```

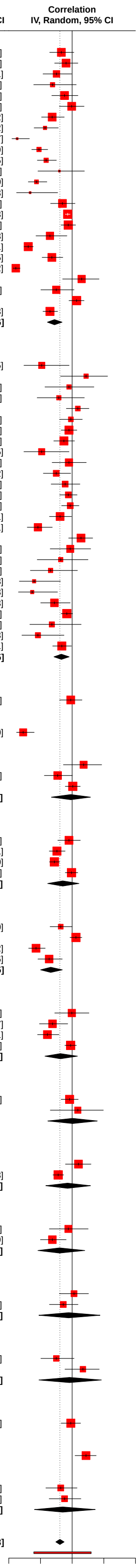
```
##
## Quantifying residual heterogeneity:
##  tau^2 = 0.0605; tau = 0.2460; I^2 = 86.4%; H = 2.71
##
## Test of heterogeneity:
##       Q d.f.  p-value
##  564.77   82 < 0.0001
##
## Results for subgroups (random effects model):
##                             k     COR             95%-CI  tau^2    tau      Q
## PA_measure = IPAQ          25 -0.2786 [-0.3908; -0.1583] 0.0626 0.2503 329.53
## PA_measure = Accelerometer  27 -0.1695 [-0.2874; -0.0465] 0.0626 0.2503  57.93
## PA_measure = Diary          1 -0.0220 [-0.5033;  0.4697] 0.0626 0.2503   0.00
## PA_measure = UCLA           1 -0.7730 [-0.9265; -0.3987] 0.0626 0.2503   0.00
## PA_measure = Pedometer      3 -0.0210 [-0.3275;  0.2895] 0.0626 0.2503   4.85
## PA_measure = Questionnaire  4 -0.1487 [-0.3868;  0.1081] 0.0626 0.2503  19.88
## PA_measure = BHPAQ          4 -0.3376 [-0.4988; -0.1538] 0.0626 0.2503  47.97
## PA_measure = SGPALS         4 -0.1857 [-0.4300;  0.0840] 0.0626 0.2503  15.27
## PA_measure = GPAQ           2  0.0081 [-0.3831;  0.3968] 0.0626 0.2503   0.30
## PA_measure = MLTPAQ         2 -0.0721 [-0.4160;  0.2898] 0.0626 0.2503   7.97
## PA_measure = GLTEQ          2 -0.1985 [-0.5409;  0.2004] 0.0626 0.2503   1.75
## PA_measure = LTPAI          2 -0.0554 [-0.5246;  0.4397] 0.0626 0.2503   1.02
## PA_measure = SQUASH         2 -0.0418 [-0.5243;  0.4609] 0.0626 0.2503   4.29
## PA_measure = PASE           1 -0.0210 [-0.4967;  0.4644] 0.0626 0.2503   0.00
## PA_measure = JPAS           1  0.2190 [-0.2990;  0.6373] 0.0626 0.2503   0.00
## PA_measure = RAPAQ          2 -0.1501 [-0.5945;  0.3645] 0.0626 0.2503   0.11
##                             I^2
## PA_measure = IPAQ          92.7%
## PA_measure = Accelerometer 55.1%
## PA_measure = Diary            --
## PA_measure = UCLA             --
## PA_measure = Pedometer     58.8%
## PA_measure = Questionnaire 84.9%
## PA_measure = BHPAQ         93.7%
## PA_measure = SGPALS        80.4%
## PA_measure = GPAQ           0.0%
## PA_measure = MLTPAQ        87.4%
## PA_measure = GLTEQ         42.7%
## PA_measure = LTPAI          2.2%
## PA_measure = SQUASH        76.7%
## PA_measure = PASE             --
## PA_measure = JPAS             --
## PA_measure = RAPAQ          0.0%
##
## Test for subgroup differences (random effects model):
##                   F   d.f. p-value
## Between groups 1.33 15, 67  0.2092
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
##   (assuming common tau^2 in subgroups)
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 82)
```

```
## - Prediction interval based on t-distribution (df = 81)
## - Fisher's z transformation of correlations
```

We also found no evidence of a moderating effect of physical activity instruments (p = 0.209), physical activity outcome (p = 0.685), or kinesiophobia instrument (p = 0.452).

```r
forest(PAm,
            layout = "Revman5",
            common = FALSE,
            xlim = c(-1.0, 1.0),
            prediction = TRUE,
            fs.hetstat = 10,
            col.subgroup = 'black',
            addrows.below.overall = 2)
```

Study or Subgroup	Cluster	Total	Weight	Correlation IV, Random, 95% CI
PA_measure = IPAQ				
Alamam, 2019	sample_1	100	1.6%	−0.17 [−0.35; 0.03]
Altug, 2016	sample_3	112	1.6%	−0.10 [−0.28; 0.09]
Aykut Selcuk, 2020	sample_7	67	1.1%	−0.25 [−0.46; −0.01]
Aykut Selcuk, 2020	sample_7	29	0.5%	−0.31 [−0.61; 0.06]
Baday−Keskin, 2022	sample_8	88	1.6%	−0.12 [−0.32; 0.09]
Bahar Ozdemir, 2021	sample_10	101	1.6%	−0.01 [−0.20; 0.19]
Baykal Sahin, 2021	sample_11	98	1.6%	−0.32 [−0.48; −0.12]
Dabek, 2020	sample_17	72	0.3%	−0.43 [−0.60; −0.22]
Dabek, 2020	sample_17	18	0.1%	−0.87 [−0.95; −0.67]
Dabek, 2020	sample_17	130	0.5%	−0.52 [−0.64; −0.39]
Dabek, 2020	sample_17	119	0.5%	−0.41 [−0.55; −0.25]
Dabek, 2020	sample_17	27	0.1%	−0.20 [−0.54; 0.19]
Dabek, 2020	sample_17	86	0.4%	−0.56 [−0.69; −0.40]
Dabek, 2020	sample_17	15	0.1%	−0.66 [−0.88; −0.23]
Demirbuken, 2016	sample_18	99	1.6%	−0.15 [−0.34; 0.05]
Demmelmaier, 2018	sample_19	2569	1.8%	−0.07 [−0.11; −0.03]
Dogan, 2022	sample_20	290	1.8%	−0.06 [−0.17; 0.05]
Donnarumma, 2017	sample_21	51	1.4%	−0.35 [−0.57; −0.08]
Kilinc, 2019	sample_27	200	1.7%	−0.69 [−0.76; −0.61]
Marques−Sule, 2022	sample_32	117	1.6%	−0.32 [−0.47; −0.15]
Ozer, 2022	sample_41	62	1.5%	−0.89 [−0.93; −0.82]
Ozlu, 2022	sample_42	45	1.4%	0.15 [−0.15; 0.42]
Priore, 2020	sample_48	50	1.4%	−0.25 [−0.49; 0.03]
Rabey, 2017	sample_49	266	1.8%	0.07 [−0.05; 0.19]
Wang , 2023	sample_60	223	1.7%	−0.35 [−0.46; −0.23]
Total (95% CI)		**5034**	**29.2%**	**−0.28 [−0.39; −0.16]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 329.53$, df = 24 (P < 0.01); $I^2 = 93\%$				
PA_measure = Accelerometer				
Alschuler, 2011	sample_2	20	1.0%	−0.48 [−0.76; −0.05]
Alzahrani, 2021	sample_4	26	0.5%	0.22 [−0.18; 0.56]
Alzahrani, 2021	sample_4	26	0.5%	−0.05 [−0.43; 0.34]
Alzahrani, 2021	sample_4	26	0.5%	−0.21 [−0.55; 0.19]
Carvalho, 2017	sample_13	119	0.6%	0.09 [−0.09; 0.27]
Carvalho, 2017	sample_13	119	0.6%	−0.02 [−0.20; 0.16]
Coronado, 2021	sample_14	248	1.7%	−0.05 [−0.17; 0.08]
Cromert, 2021	sample_16	139	1.7%	−0.13 [−0.29; 0.04]
Glaviano, 2017	sample_23	20	1.0%	−0.48 [−0.76; −0.05]
Helmus, 2012	sample_24	53	1.4%	−0.05 [−0.32; 0.22]
Igelstrom, 2013	sample_26	73	0.9%	−0.25 [−0.45; −0.02]
Igelstrom, 2013	sample_26	73	0.9%	−0.11 [−0.33; 0.12]
Koppenaal, 2023	sample_29	204	0.9%	−0.06 [−0.20; 0.08]
Koppenaal, 2023	sample_29	204	0.9%	−0.03 [−0.17; 0.11]
Lotzke, 2018	sample_30	118	1.6%	−0.19 [−0.36; −0.01]
Miller, 2018	sample_37	52	1.4%	−0.54 [−0.71; −0.31]
Pedler, 2018	sample_45	103	1.6%	0.14 [−0.06; 0.32]
Polaski, 2021	sample_47	38	1.3%	−0.03 [−0.35; 0.29]
Smulligan, 2023	sample_54	23	0.5%	−0.18 [−0.55; 0.25]
Smulligan, 2023	sample_54	23	0.5%	−0.34 [−0.66; 0.08]
Smulligan, 2023	sample_54	18	0.3%	−0.60 [−0.83; −0.18]
Smulligan, 2023	sample_54	18	0.3%	−0.63 [−0.85; −0.23]
Spaderna, 2020	sample_55	61	1.5%	−0.28 [−0.50; −0.03]
Strandberg, 2022	sample_56	451	1.8%	−0.08 [−0.17; 0.01]
Sutcu, 2021	sample_57	20	0.7%	−0.32 [−0.67; 0.14]
Sutcu, 2021	sample_57	20	0.7%	−0.54 [−0.79; −0.13]
Uritani, 2020	sample_59	167	1.7%	−0.16 [−0.31; −0.01]
Total (95% CI)		**2462**	**27.0%**	**−0.17 [−0.29; −0.05]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 57.93$, df = 26 (P < 0.01); $I^2 = 55\%$				
PA_measure = Diary				
Assadourian, 2020	sample_5	123	1.6%	−0.02 [−0.20; 0.16]
PA_measure = UCLA				
Aydemir, 2022	sample_6	37	1.3%	−0.77 [−0.88; −0.60]
PA_measure = Pedometer				
Baez, 2020	sample_9	40	1.3%	0.18 [−0.14; 0.47]
Minetama, 2022	sample_38	71	1.5%	−0.23 [−0.44; 0.00]
Pastor−Mira, 2020	sample_44	274	1.8%	0.01 [−0.11; 0.13]
Total (95% CI)		**385**	**4.6%**	**−0.02 [−0.33; 0.29]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 4.85$, df = 2 (P = 0.09); $I^2 = 59\%$				
PA_measure = Questionnaire				
Bernard, 2015	sample_12	121	1.6%	−0.05 [−0.23; 0.13]
Marshall, 2017	sample_33	218	1.7%	−0.24 [−0.36; −0.11]
Marshall, 2021	sample_34	508	1.8%	−0.28 [−0.36; −0.20]
Marshall, 2022	sample_35	393	1.8%	−0.01 [−0.11; 0.09]
Total (95% CI)		**1240**	**7.0%**	**−0.15 [−0.39; 0.11]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 19.88$, df = 3 (P < 0.01); $I^2 = 85\%$				
PA_measure = BHPAQ				
Carvalho, 2017	sample_13	119	0.6%	−0.18 [−0.35; −0.00]
Luthi, 2022	sample_31	433	1.8%	0.06 [−0.03; 0.15]
Saulicz, 2016	sample_52	105	1.6%	−0.57 [−0.69; −0.42]
Wasiuk−Zowada, 2022	sample_61	80	1.5%	−0.36 [−0.54; −0.16]
Total (95% CI)		**737**	**5.6%**	**−0.34 [−0.50; −0.15]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 47.97$, df = 3 (P < 0.01); $I^2 = 94\%$				
PA_measure = SGPALS				
Corrigan, 2018	sample_15	53	1.4%	−0.00 [−0.27; 0.27]
Elfving, 2007	sample_22	64	1.5%	−0.31 [−0.52; −0.07]
Roaldsen, 2009	sample_50	98	1.6%	−0.39 [−0.55; −0.21]
Sandal, 2021	sample_51	460	1.8%	−0.02 [−0.12; 0.07]
Total (95% CI)		**675**	**6.3%**	**−0.19 [−0.43; 0.08]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 15.27$, df = 3 (P < 0.01); $I^2 = 80\%$				
PA_measure = GPAQ				
Ho−A−Tham, 2022	sample_25	210	1.7%	−0.04 [−0.17; 0.10]
Masse−Alarie, 2016	sample_36	22	1.0%	0.09 [−0.34; 0.49]
Total (95% CI)		**232**	**2.7%**	**0.01 [−0.38; 0.40]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 0.3$, df = 1 (P = 0.59); $I^2 = 0\%$				
PA_measure = MLTPAQ				
Koho, 2011	sample_28	93	1.6%	0.10 [−0.11; 0.30]
Zelle, 2016	sample_63	487	1.8%	−0.22 [−0.30; −0.13]
Total (95% CI)		**580**	**3.4%**	**−0.07 [−0.42; 0.29]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 7.97$, df = 1 (P < 0.01); $I^2 = 87\%$				
PA_measure = GLTEQ				
Navarro−Ledesma, 2022	sample_39	41	1.3%	−0.06 [−0.36; 0.25]
Norte, 2019	sample_40	77	1.5%	−0.31 [−0.50; −0.09]
Total (95% CI)		**118**	**2.8%**	**−0.20 [−0.54; 0.20]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 1.75$, df = 1 (P = 0.19); $I^2 = 43\%$				
PA_measure = LTPAI				
Palstam, 2014	sample_43	73	0.9%	0.03 [−0.20; 0.26]
Palstam, 2014	sample_43	73	0.9%	−0.14 [−0.36; 0.09]
Total (95% CI)		**146**	**1.7%**	**−0.06 [−0.52; 0.44]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 1.02$, df = 1 (P = 0.31); $I^2 = 2\%$				
PA_measure = SQUASH				
Peres, 2023	sample_46	50	0.8%	−0.25 [−0.49; 0.03]
Peres, 2023	sample_46	50	0.8%	0.17 [−0.11; 0.43]
Total (95% CI)		**100**	**1.7%**	**−0.04 [−0.52; 0.46]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 4.29$, df = 1 (P = 0.04); $I^2 = 77\%$				
PA_measure = PASE				
Sertel, 2021	sample_53	163	1.7%	−0.02 [−0.17; 0.13]
PA_measure = JPAS				
Suttmiller, 2022	sample_58	126	1.6%	0.22 [0.05; 0.38]
PA_measure = RAPAQ				
Zadro, 2019	sample_62	60	0.9%	−0.18 [−0.41; 0.08]
Zadro, 2019	sample_62	60	0.9%	−0.12 [−0.36; 0.14]
Total (95% CI)		**120**	**1.7%**	**−0.15 [−0.59; 0.36]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 0.11$, df = 1 (P = 0.74); $I^2 = 0\%$				
Total (95% CI)		**12278**	**100.0%**	**−0.19 [−0.26; −0.13]**
Prediction interval				**[−0.61; 0.30]**



Heterogeneity: $Tau^2 = 0.0634$; $Chi^2 = 564.77$, df = 82 (P < 0.01); $I^2 = 85\%$
Residual heterogeneity: $Tau^2 = 0.0605$; $Chi^2 = 490.86$, df = 67 (P < 0.01); $I^2 = 86\%$
Test for subgroup differences: F = 1.33, df = 15, 67 (P = 0.21)

```r
png(file = "Physical activity measure forestplot.png",
    width = 2800, height = 8400, res = 300)

forest(PAm,
        layout = "Revman5",
        sortvar = -TE,
        common = FALSE,
        xlim = c(-1.0, 1.0),
        prediction = TRUE,
        fs.hetstat = 10,
        col.subgroup = 'black',
        addrows.below.overall = 2)

dev.off()
```

```
## pdf
##   2
```

Subgroup analysis by physical activity outcome

```r
Kinphob_r$PA_outcome <- as.factor(Kinphob_r$PA_outcome)

PAout_subg <- rma.mv(yi = z,
                     V = var.z,
                     slab = author,
                     data = Kinphob_r,
                     random = ~ 1 | author/cor_id,
                     test = "t",
                     method = "REML",
                     mods = ~ PA_outcome)

summary(PAout_subg)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
## -11.7574   23.5148   39.5148   58.2652   41.6324
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0641  0.2531     63     no         author
## sigma^2.2  0.0017  0.0416     83     no  author/cor_id
##
## Test for Residual Heterogeneity:
## QE(df = 77) = 553.8532, p-val < .0001
##
## Test of Moderators (coefficients 2:6):
## F(df1 = 5, df2 = 77) = 0.7209, p-val = 0.6098
##
## Model Results:
##
##                           estimate      se     tval  df     pval    ci.lb   ci.ub
```

```
## intrcpt                   -0.1085  0.0718  -1.5110  77  0.1349  -0.2514  0.0345
## PA_outcomeCounts/min      -0.0372  0.1074  -0.3465  77  0.7299  -0.2510  0.1766
## PA_outcomeKcal/day        -0.2936  0.2202  -1.3331  77  0.1864  -0.7321  0.1449
## PA_outcomeMET-min/week    -0.0917  0.0896  -1.0232  77  0.3094  -0.2702  0.0868
## PA_outcomeScore           -0.1353  0.0884  -1.5313  77  0.1298  -0.3113  0.0406
## PA_outcomeSteps/day       -0.0756  0.0933  -0.8104  77  0.4202  -0.2614  0.1102
##
## intrcpt
## PA_outcomeCounts/min
## PA_outcomeKcal/day
## PA_outcomeMET-min/week
## PA_outcomeScore
## PA_outcomeSteps/day
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

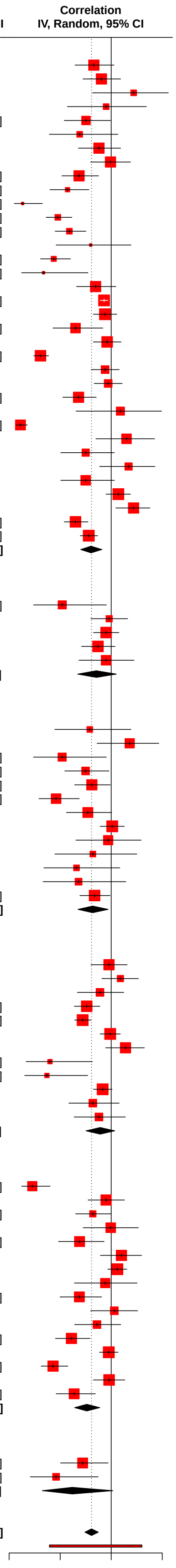
```r
PAout <- update(m,
       subgroup = PA_outcome,
       tau.common = TRUE)
PAout
```

```
## Review:     Primary meta-analysis using metacor
##
## Number of studies: n = 63
## Number of estimates: k = 83
## Number of observations: o = 12278
##
##                             COR             95%-CI     t  p-value
## Random effects model -0.1931 [-0.2579; -0.1266] -5.70 < 0.0001
## Prediction interval           [-0.6051;  0.3004]
##
## Quantifying heterogeneity:
##  tau^2.1 = 0.0576 [0.0227; 0.0950]; tau.1 = 0.2399 [0.1508; 0.3082] (between cluster)
##  tau^2.2 = 0.0058 [0.0000; 0.0398]; tau.2 = 0.0762 [0.0000; 0.1995] (within cluster)
##  I^2 = 85.5% [82.6%; 87.9%]; H = 2.62 [2.40; 2.87]
##
## Quantifying residual heterogeneity:
##  tau^2 = 0.0684; tau = 0.2616; I^2 = 86.1%; H = 2.68
##
## Test of heterogeneity:
##       Q d.f.  p-value
##  564.77   82 < 0.0001
##
## Results for subgroups (random effects model):
##                                 k     COR             95%-CI  tau^2    tau      Q
## PA_outcome = MET-min/week   35 -0.1975 [-0.2992; -0.0915] 0.0658 0.2565 371.71
## PA_outcome = Counts/min      5 -0.1447 [-0.3282;  0.0494] 0.0658 0.2565   4.37
## PA_outcome = Steps/day      13 -0.1820 [-0.3256; -0.0302] 0.0658 0.2565  27.04
## PA_outcome = Active time    12 -0.1080 [-0.2462;  0.0345] 0.0658 0.2565  46.81
## PA_outcome = Score          16 -0.2391 [-0.3583; -0.1122] 0.0658 0.2565 102.61
## PA_outcome = Kcal/day        2 -0.3817 [-0.6747;  0.0153] 0.0658 0.2565   1.32
##                                 I^2
## PA_outcome = MET-min/week  90.9%
## PA_outcome = Counts/min     8.4%
```

```
## PA_outcome = Steps/day     55.6%
## PA_outcome = Active time   76.5%
## PA_outcome = Score         85.4%
## PA_outcome = Kcal/day      24.1%
##
## Test for subgroup differences (random effects model):
##                   F  d.f. p-value
## Between groups 0.72 5, 77  0.6098
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
##   (assuming common tau^2 in subgroups)
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 82)
## - Prediction interval based on t-distribution (df = 81)
## - Fisher's z transformation of correlations
```

```r
forest(PAout,
            layout = "RevMan5",
            common = FALSE,
            xlim = c(-1.0, 0.6),
            prediction = TRUE,
            fs.hetstat = 10,
            col.subgroup = 'black',
            addrows.below.overall = 2)
```

Study or Subgroup	Cluster	Total	Weight	Correlation IV, Random, 95% CI
PA_outcome = MET−min/week				
Alamam, 2019	sample_1	100	1.6%	−0.17 [−0.35; 0.03]
Altug, 2016	sample_3	112	1.6%	−0.10 [−0.28; 0.09]
Alzahrani, 2021	sample_4	26	0.5%	0.22 [−0.18; 0.56]
Alzahrani, 2021	sample_4	26	0.5%	−0.05 [−0.43; 0.34]
Aykut Selcuk, 2020	sample_7	67	1.1%	−0.25 [−0.46; −0.01]
Aykut Selcuk, 2020	sample_7	29	0.5%	−0.31 [−0.61; 0.06]
Baday−Keskin, 2022	sample_8	88	1.6%	−0.12 [−0.32; 0.09]
Bahar Ozdemir, 2021	sample_10	101	1.6%	−0.01 [−0.20; 0.19]
Baykal Sahin, 2021	sample_11	98	1.6%	−0.32 [−0.48; −0.12]
Dabek, 2020	sample_17	72	0.3%	−0.43 [−0.60; −0.22]
Dabek, 2020	sample_17	18	0.1%	−0.87 [−0.95; −0.67]
Dabek, 2020	sample_17	130	0.5%	−0.52 [−0.64; −0.39]
Dabek, 2020	sample_17	119	0.5%	−0.41 [−0.55; −0.25]
Dabek, 2020	sample_17	27	0.1%	−0.20 [−0.54; 0.19]
Dabek, 2020	sample_17	86	0.4%	−0.56 [−0.69; −0.40]
Dabek, 2020	sample_17	15	0.1%	−0.66 [−0.88; −0.23]
Demirbuken, 2016	sample_18	99	1.6%	−0.15 [−0.34; 0.05]
Demmelmaier, 2018	sample_19	2569	1.8%	−0.07 [−0.11; −0.03]
Dogan, 2022	sample_20	290	1.8%	−0.06 [−0.17; 0.05]
Donnarumma, 2017	sample_21	51	1.4%	−0.35 [−0.57; −0.08]
Ho−A−Tham, 2022	sample_25	210	1.7%	−0.04 [−0.17; 0.10]
Kilinc, 2019	sample_27	200	1.7%	−0.69 [−0.76; −0.61]
Koppenaal, 2023	sample_29	204	0.9%	−0.06 [−0.20; 0.08]
Koppenaal, 2023	sample_29	204	0.9%	−0.03 [−0.17; 0.11]
Marques−Sule, 2022	sample_32	117	1.6%	−0.32 [−0.47; −0.15]
Masse−Alarie, 2016	sample_36	22	1.0%	0.09 [−0.34; 0.49]
Ozer, 2022	sample_41	62	1.5%	−0.89 [−0.93; −0.82]
Ozlu, 2022	sample_42	45	1.4%	0.15 [−0.15; 0.42]
Peres, 2023	sample_46	50	0.8%	−0.25 [−0.49; 0.03]
Peres, 2023	sample_46	50	0.8%	0.17 [−0.11; 0.43]
Priore, 2020	sample_48	50	1.4%	−0.25 [−0.49; 0.03]
Rabey, 2017	sample_49	266	1.8%	0.07 [−0.05; 0.19]
Suttmiller, 2022	sample_58	126	1.6%	0.22 [0.05; 0.38]
Wang , 2023	sample_60	223	1.7%	−0.35 [−0.46; −0.23]
Zelle, 2016	sample_63	487	1.8%	−0.22 [−0.30; −0.13]
Total (95% CI)		**6439**	**40.0%**	**−0.20 [−0.30; −0.09]**
Heterogeneity: $Tau^2 = 0.0658$; $Chi^2 = 371.71$, df = 34 ($P < 0.01$); $I^2 = 91\%$				
PA_outcome = Counts/min				
Alschuler, 2011	sample_2	20	1.0%	−0.48 [−0.76; −0.05]
Carvalho, 2017	sample_13	119	0.6%	−0.02 [−0.20; 0.16]
Coronado, 2021	sample_14	248	1.7%	−0.05 [−0.17; 0.08]
Cromert, 2021	sample_16	139	1.7%	−0.13 [−0.29; 0.04]
Helmus, 2012	sample_24	53	1.4%	−0.05 [−0.32; 0.22]
Total (95% CI)		**579**	**6.4%**	**−0.14 [−0.33; 0.05]**
Heterogeneity: $Tau^2 = 0.0658$; $Chi^2 = 4.37$, df = 4 ($P = 0.36$); $I^2 = 8\%$				
PA_outcome = Steps/day				
Alzahrani, 2021	sample_4	26	0.5%	−0.21 [−0.55; 0.19]
Baez, 2020	sample_9	40	1.3%	0.18 [−0.14; 0.47]
Glaviano, 2017	sample_23	20	1.0%	−0.48 [−0.76; −0.05]
Igelstrom, 2013	sample_26	73	0.9%	−0.25 [−0.45; −0.02]
Lotzke, 2018	sample_30	118	1.6%	−0.19 [−0.36; −0.01]
Miller, 2018	sample_37	52	1.4%	−0.54 [−0.71; −0.31]
Minetama, 2022	sample_38	71	1.5%	−0.23 [−0.44; 0.00]
Pastor−Mira, 2020	sample_44	274	1.8%	0.01 [−0.11; 0.13]
Polaski, 2021	sample_47	38	1.3%	−0.03 [−0.35; 0.29]
Smulligan, 2023	sample_54	23	0.5%	−0.18 [−0.55; 0.25]
Smulligan, 2023	sample_54	23	0.5%	−0.34 [−0.66; 0.08]
Sutcu, 2021	sample_57	20	0.7%	−0.32 [−0.67; 0.14]
Uritani, 2020	sample_59	167	1.7%	−0.16 [−0.31; −0.01]
Total (95% CI)		**945**	**14.5%**	**−0.18 [−0.33; −0.03]**
Heterogeneity: $Tau^2 = 0.0658$; $Chi^2 = 27.04$, df = 12 ($P < 0.01$); $I^2 = 56\%$				
PA_outcome = Active time				
Assadourian, 2020	sample_5	123	1.6%	−0.02 [−0.20; 0.16]
Carvalho, 2017	sample_13	119	0.6%	0.09 [−0.09; 0.27]
Igelstrom, 2013	sample_26	73	0.9%	−0.11 [−0.33; 0.12]
Marshall, 2017	sample_33	218	1.7%	−0.24 [−0.36; −0.11]
Marshall, 2021	sample_34	508	1.8%	−0.28 [−0.36; −0.20]
Marshall, 2022	sample_35	393	1.8%	−0.01 [−0.11; 0.09]
Pedler, 2018	sample_45	103	1.6%	0.14 [−0.06; 0.32]
Smulligan, 2023	sample_54	18	0.3%	−0.60 [−0.83; −0.18]
Smulligan, 2023	sample_54	18	0.3%	−0.63 [−0.85; −0.23]
Strandberg, 2022	sample_56	451	1.8%	−0.08 [−0.17; 0.01]
Zadro, 2019	sample_62	60	0.9%	−0.18 [−0.41; 0.08]
Zadro, 2019	sample_62	60	0.9%	−0.12 [−0.36; 0.14]
Total (95% CI)		**2144**	**14.3%**	**−0.11 [−0.25; 0.03]**
Heterogeneity: $Tau^2 = 0.0658$; $Chi^2 = 46.81$, df = 11 ($P < 0.01$); $I^2 = 77\%$				
PA_outcome = Score				
Aydemir, 2022	sample_6	37	1.3%	−0.77 [−0.88; −0.60]
Bernard, 2015	sample_12	121	1.6%	−0.05 [−0.23; 0.13]
Carvalho, 2017	sample_13	119	0.6%	−0.18 [−0.35; −0.00]
Corrigan, 2018	sample_15	53	1.4%	−0.00 [−0.27; 0.27]
Elfving, 2007	sample_22	64	1.5%	−0.31 [−0.52; −0.07]
Koho, 2011	sample_28	93	1.6%	0.10 [−0.11; 0.30]
Luthi, 2022	sample_31	433	1.8%	0.06 [−0.03; 0.15]
Navarro−Ledesma, 2022	sample_39	41	1.3%	−0.06 [−0.36; 0.25]
Norte, 2019	sample_40	77	1.5%	−0.31 [−0.50; −0.09]
Palstam, 2014	sample_43	73	0.9%	0.03 [−0.20; 0.26]
Palstam, 2014	sample_43	73	0.9%	−0.14 [−0.36; 0.09]
Roaldsen, 2009	sample_50	98	1.6%	−0.39 [−0.55; −0.21]
Sandal, 2021	sample_51	460	1.8%	−0.02 [−0.12; 0.07]
Saulicz, 2016	sample_52	105	1.6%	−0.57 [−0.69; −0.42]
Sertel, 2021	sample_53	163	1.7%	−0.02 [−0.17; 0.13]
Wasiuk−Zowada, 2022	sample_61	80	1.5%	−0.36 [−0.54; −0.16]
Total (95% CI)		**2090**	**22.6%**	**−0.24 [−0.36; −0.11]**
Heterogeneity: $Tau^2 = 0.0658$; $Chi^2 = 102.61$, df = 15 ($P < 0.01$); $I^2 = 85\%$				
PA_outcome = Kcal/day				
Spaderna, 2020	sample_55	61	1.5%	−0.28 [−0.50; −0.03]
Sutcu, 2021	sample_57	20	0.7%	−0.54 [−0.79; −0.13]
Total (95% CI)		**81**	**2.1%**	**−0.38 [−0.67; 0.02]**
Heterogeneity: $Tau^2 = 0.0658$; $Chi^2 = 1.32$, df = 1 ($P = 0.25$); $I^2 = 24\%$				
Total (95% CI)		**12278**	**100.0%**	**−0.19 [−0.26; −0.13]**
Prediction interval				**[−0.61; 0.30]**



Heterogeneity: $Tau^2 = 0.0634$; $Chi^2 = 564.77$, df = 82 ($P < 0.01$); $I^2 = 85\%$
Residual heterogeneity: $Tau^2 = 0.0684$; $Chi^2 = 553.85$, df = 77 ($P < 0.01$); $I^2 = 86\%$
Test for subgroup differences: $F = 0.72$, df = 5, 77 ($P = 0.61$)

```r
png(file = "PA outcome forestplot.png",
    width = 2800, height = 6400, res = 300)

forest(PAout,
            layout = "RevMan5",
            sortvar = -TE,
            common = FALSE,
            xlim = c(-1.0, 0.6),
            prediction = TRUE,
            fs.hetstat = 10,
            col.subgroup = 'black',
            addrows.below.overall = 2)

dev.off()
```

```
## pdf
##   2
```

Subgroup analysis by kinesiophobia measure

```r
Kinphob_r$Kinesiophobia_measure <- as.factor(Kinphob_r$Kinesiophobia_measure)

Kines_subg <- rma.mv(yi = z,
                      V = var.z,
                      slab = author,
                      data = Kinphob_r,
                      random = ~ 1 | author/cor_id,
                      test = "t",
                      method = "REML",
                      mods = ~ Kinesiophobia_measure)

summary(Kines_subg)
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
##   logLik  Deviance       AIC       BIC      AICc
##  -9.5324   19.0648   45.0648   74.6615   51.3407
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0531  0.2305     63     no         author
## sigma^2.2  0.0095  0.0976     83     no  author/cor_id
##
## Test for Residual Heterogeneity:
## QE(df = 72) = 429.2840, p-val < .0001
##
## Test of Moderators (coefficients 2:11):
## F(df1 = 10, df2 = 72) = 0.9998, p-val = 0.4520
##
## Model Results:
##
##                                   estimate      se     tval  df     pval    ci.lb
```

```
## intrcpt                         -0.3654  0.2592  -1.4098  72  0.1629  -0.8822
## Kinesiophobia_measureBFOMSO      0.2010  0.3687   0.5451  72  0.5874  -0.5340
## Kinesiophobia_measureFABQ        0.2387  0.2694   0.8860  72  0.3785  -0.2984
## Kinesiophobia_measureFActS       0.0778  0.3835   0.2028  72  0.8399  -0.6867
## Kinesiophobia_measureKCS        -0.2821  0.3737  -0.7549  72  0.4528  -1.0270
## Kinesiophobia_measureTSK_11      0.3237  0.2765   1.1704  72  0.2457  -0.2276
## Kinesiophobia_measureTSK_12      0.1591  0.3509   0.4535  72  0.6515  -0.5404
## Kinesiophobia_measureTSK_13      0.2081  0.3035   0.6858  72  0.4951  -0.3969
## Kinesiophobia_measureTSK_14      0.2812  0.3634   0.7739  72  0.4415  -0.4432
## Kinesiophobia_measureTSK_17      0.1317  0.2636   0.4995  72  0.6190  -0.3938
## Kinesiophobia_measureTSK_Heart  -0.1916  0.3527  -0.5432  72  0.5887  -0.8947
##                                 ci.ub
## intrcpt                        0.1513
## Kinesiophobia_measureBFOMSO     0.9359
## Kinesiophobia_measureFABQ       0.7758
## Kinesiophobia_measureFActS      0.8423
## Kinesiophobia_measureKCS        0.4628
## Kinesiophobia_measureTSK_11     0.8749
## Kinesiophobia_measureTSK_12     0.8587
## Kinesiophobia_measureTSK_13     0.8132
## Kinesiophobia_measureTSK_14     1.0057
## Kinesiophobia_measureTSK_17     0.6571
## Kinesiophobia_measureTSK_Heart  0.5115
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
Kin_sub <- update(m,
       subgroup = Kinesiophobia_measure,
       tau.common = TRUE)
```

```
## Warning: Single-level factor(s) found in 'random' argument. Corresponding
## 'sigma2' value(s) fixed to 0.
```

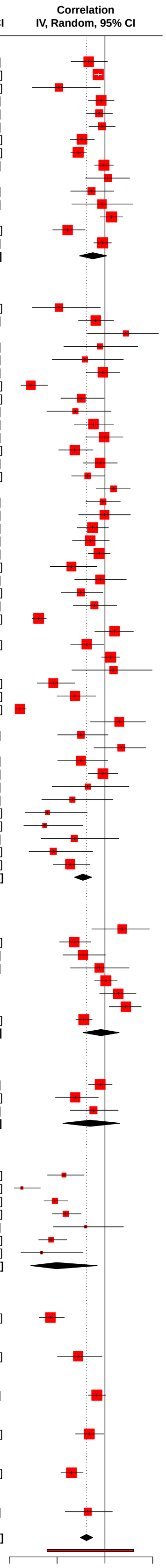
```r
Kin_sub
```

```
## Review:     Primary meta-analysis using metacor
##
## Number of studies: n = 63
## Number of estimates: k = 83
## Number of observations: o = 12278
##
##                             COR            95%-CI     t  p-value
## Random effects model -0.1931 [-0.2579; -0.1266] -5.70 < 0.0001
## Prediction interval          [-0.6051;  0.3004]
##
## Quantifying heterogeneity:
##  tau^2.1 = 0.0576 [0.0227; 0.0950]; tau.1 = 0.2399 [0.1508; 0.3082] (between cluster)
##  tau^2.2 = 0.0058 [0.0000; 0.0398]; tau.2 = 0.0762 [0.0000; 0.1995] (within cluster)
##  I^2 = 85.5% [82.6%; 87.9%]; H = 2.62 [2.40; 2.87]
##
## Quantifying residual heterogeneity:
##  tau^2 = 0.0575; tau = 0.2397; I^2 = 83.2%; H = 2.44
##
## Test of heterogeneity:
##       Q d.f.  p-value
```

```
##  564.77   82 < 0.0001
##
## Results for subgroups (random effects model):
##                                     k     COR            95%-CI  tau^2    tau
## Kinesiophobia_measure = FABQ       15 -0.1261 [-0.2666;  0.0197] 0.0626 0.2503
## Kinesiophobia_measure = TSK_17     44 -0.2296 [-0.3177; -0.1376] 0.0626 0.2503
## Kinesiophobia_measure = TSK_11      8 -0.0418 [-0.2297;  0.1492] 0.0626 0.2503
## Kinesiophobia_measure = TSK_13      3 -0.1560 [-0.4399;  0.1562] 0.0626 0.2503
## Kinesiophobia_measure = TSK_Heart   7 -0.5058 [-0.7755; -0.0800] 0.0626 0.2503
## Kinesiophobia_measure = KCS         1 -0.5700 [-0.8287; -0.1105] 0.0626 0.2503
## Kinesiophobia_measure = FActS       1 -0.2800 [-0.6917;  0.2690] 0.0626 0.2503
## Kinesiophobia_measure = TSK_14      1 -0.0840 [-0.5313;  0.3999] 0.0626 0.2503
## Kinesiophobia_measure = BFOMSO      1 -0.1630 [-0.5961;  0.3436] 0.0626 0.2503
## Kinesiophobia_measure = BBQ         1 -0.3500 [-0.7075;  0.1501] 0.0626 0.2503
## Kinesiophobia_measure = TSK_12      1 -0.2034 [-0.5901;  0.2592] 0.0626 0.2503
##                                        Q   I^2
## Kinesiophobia_measure = FABQ       53.53 73.8%
## Kinesiophobia_measure = TSK_17    317.14 86.4%
## Kinesiophobia_measure = TSK_11     39.55 82.3%
## Kinesiophobia_measure = TSK_13      3.59 44.2%
## Kinesiophobia_measure = TSK_Heart  15.47 61.2%
## Kinesiophobia_measure = KCS         0.00    --
## Kinesiophobia_measure = FActS       0.00    --
## Kinesiophobia_measure = TSK_14      0.00    --
## Kinesiophobia_measure = BFOMSO      0.00    --
## Kinesiophobia_measure = BBQ         0.00    --
## Kinesiophobia_measure = TSK_12      0.00    --
##
## Test for subgroup differences (random effects model):
##                   F   d.f. p-value
## Between groups 1.00 10, 72  0.4520
##
## Details on meta-analytical method:
## - Inverse variance method (three-level model)
## - Restricted maximum-likelihood estimator for tau^2
##   (assuming common tau^2 in subgroups)
## - Profile-Likelihood method for confidence interval of tau^2 and tau
## - Random effects confidence interval based on t-distribution (df = 82)
## - Prediction interval based on t-distribution (df = 81)
## - Fisher's z transformation of correlations
```

```r
forest(Kin_sub,
      layout = "Revman5",
      common = FALSE,
      xlim = c(-1.0, 0.6),
      prediction = TRUE,
      fs.hetstat = 10,
      col.subgroup = 'black',
      addrows.below.overall = 2)
```

Study or Subgroup	Cluster	Total	Weight	Correlation IV, Random, 95% CI
Kinesiophobia_measure = FABQ				
Alamam, 2019	sample_1	100	1.6%	−0.17 [−0.35; 0.03]
Demmelmaier, 2018	sample_19	2569	1.8%	−0.07 [−0.11; −0.03]
Glaviano, 2017	sample_23	20	1.0%	−0.48 [−0.76; −0.05]
Ho−A−Tham, 2022	sample_25	210	1.7%	−0.04 [−0.17; 0.10]
Koppenaal, 2023	sample_29	204	0.9%	−0.06 [−0.20; 0.08]
Koppenaal, 2023	sample_29	204	0.9%	−0.03 [−0.17; 0.11]
Marshall, 2017	sample_33	218	1.7%	−0.24 [−0.36; −0.11]
Marshall, 2021	sample_34	508	1.8%	−0.28 [−0.36; −0.20]
Marshall, 2022	sample_35	393	1.8%	−0.01 [−0.11; 0.09]
Palstam, 2014	sample_43	73	0.9%	0.03 [−0.20; 0.26]
Palstam, 2014	sample_43	73	0.9%	−0.14 [−0.36; 0.09]
Polaski, 2021	sample_47	38	1.3%	−0.03 [−0.35; 0.29]
Rabey, 2017	sample_49	266	1.8%	0.07 [−0.05; 0.19]
Roaldsen, 2009	sample_50	98	1.6%	−0.39 [−0.55; −0.21]
Sandal, 2021	sample_51	460	1.8%	−0.02 [−0.12; 0.07]
Total (95% CI)		**5434**	**21.5%**	**−0.13 [−0.27; 0.02]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 53.53$, df = 14 ($P < 0.01$); $I^2 = 74\%$				
Kinesiophobia_measure = TSK_17				
Alschuler, 2011	sample_2	20	1.0%	−0.48 [−0.76; −0.05]
Altug, 2016	sample_3	112	1.6%	−0.10 [−0.28; 0.09]
Alzahrani, 2021	sample_4	26	0.5%	0.22 [−0.18; 0.56]
Alzahrani, 2021	sample_4	26	0.5%	−0.05 [−0.43; 0.34]
Alzahrani, 2021	sample_4	26	0.5%	−0.21 [−0.55; 0.19]
Assadourian, 2020	sample_5	123	1.6%	−0.02 [−0.20; 0.16]
Aydemir, 2022	sample_6	37	1.3%	−0.77 [−0.88; −0.60]
Aykut Selcuk, 2020	sample_7	67	1.1%	−0.25 [−0.46; −0.01]
Aykut Selcuk, 2020	sample_7	29	0.5%	−0.31 [−0.61; 0.06]
Baday−Keskin, 2022	sample_8	88	1.6%	−0.12 [−0.32; 0.09]
Bahar Ozdemir, 2021	sample_10	101	1.6%	−0.01 [−0.20; 0.19]
Baykal Sahin, 2021	sample_11	98	1.6%	−0.32 [−0.48; −0.12]
Bernard, 2015	sample_12	121	1.6%	−0.05 [−0.23; 0.13]
Carvalho, 2017	sample_13	119	0.6%	−0.18 [−0.35; −0.00]
Carvalho, 2017	sample_13	119	0.6%	0.09 [−0.09; 0.27]
Carvalho, 2017	sample_13	119	0.6%	−0.02 [−0.20; 0.16]
Corrigan, 2018	sample_15	53	1.4%	−0.00 [−0.27; 0.27]
Cromert, 2021	sample_16	139	1.7%	−0.13 [−0.29; 0.04]
Demirbuken, 2016	sample_18	99	1.6%	−0.15 [−0.34; 0.05]
Dogan, 2022	sample_20	290	1.8%	−0.06 [−0.17; 0.05]
Donnarumma, 2017	sample_21	51	1.4%	−0.35 [−0.57; −0.08]
Helmus, 2012	sample_24	53	1.4%	−0.05 [−0.32; 0.22]
Igelstrom, 2013	sample_26	73	0.9%	−0.25 [−0.45; −0.02]
Igelstrom, 2013	sample_26	73	0.9%	−0.11 [−0.33; 0.12]
Kilinc, 2019	sample_27	200	1.7%	−0.69 [−0.76; −0.61]
Koho, 2011	sample_28	93	1.6%	0.10 [−0.11; 0.30]
Lotzke, 2018	sample_30	118	1.6%	−0.19 [−0.36; −0.01]
Luthi, 2022	sample_31	433	1.8%	0.06 [−0.03; 0.15]
Masse−Alarie, 2016	sample_36	22	1.0%	0.09 [−0.34; 0.49]
Miller, 2018	sample_37	52	1.4%	−0.54 [−0.71; −0.31]
Norte, 2019	sample_40	77	1.5%	−0.31 [−0.50; −0.09]
Ozer, 2022	sample_41	62	1.5%	−0.89 [−0.93; −0.82]
Ozlu, 2022	sample_42	45	1.4%	0.15 [−0.15; 0.42]
Peres, 2023	sample_46	50	0.8%	−0.25 [−0.49; 0.03]
Peres, 2023	sample_46	50	0.8%	0.17 [−0.11; 0.43]
Priore, 2020	sample_48	50	1.4%	−0.25 [−0.49; 0.03]
Sertel, 2021	sample_53	163	1.7%	−0.02 [−0.17; 0.13]
Smulligan, 2023	sample_54	23	0.5%	−0.18 [−0.55; 0.25]
Smulligan, 2023	sample_54	23	0.5%	−0.34 [−0.66; 0.08]
Smulligan, 2023	sample_54	18	0.3%	−0.60 [−0.83; −0.18]
Smulligan, 2023	sample_54	18	0.3%	−0.63 [−0.85; −0.23]
Sutcu, 2021	sample_57	20	0.7%	−0.32 [−0.67; 0.14]
Sutcu, 2021	sample_57	20	0.7%	−0.54 [−0.79; −0.13]
Wasiuk−Zowada, 2022	sample_61	80	1.5%	−0.36 [−0.54; −0.16]
Total (95% CI)		**3679**	**50.7%**	**−0.23 [−0.32; −0.14]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 317.14$, df = 43 ($P < 0.01$); $I^2 = 86\%$				
Kinesiophobia_measure = TSK_11				
Baez, 2020	sample_9	40	1.3%	0.18 [−0.14; 0.47]
Marques−Sule, 2022	sample_32	117	1.6%	−0.32 [−0.47; −0.15]
Minetama, 2022	sample_38	71	1.5%	−0.23 [−0.44; 0.00]
Navarro−Ledesma, 2022	sample_39	41	1.3%	−0.06 [−0.36; 0.25]
Pastor−Mira, 2020	sample_44	274	1.8%	0.01 [−0.11; 0.13]
Pedler, 2018	sample_45	103	1.6%	0.14 [−0.06; 0.32]
Suttmiller, 2022	sample_58	126	1.6%	0.22 [0.05; 0.38]
Zelle, 2016	sample_63	487	1.8%	−0.22 [−0.30; −0.13]
Total (95% CI)		**1259**	**12.6%**	**−0.04 [−0.23; 0.15]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 39.55$, df = 7 ($P < 0.01$); $I^2 = 82\%$				
Kinesiophobia_measure = TSK_13				
Coronado, 2021	sample_14	248	1.7%	−0.05 [−0.17; 0.08]
Elfving, 2007	sample_22	64	1.5%	−0.31 [−0.52; −0.07]
Zadro, 2019	sample_62	60	0.9%	−0.12 [−0.36; 0.14]
Total (95% CI)		**372**	**4.1%**	**−0.16 [−0.44; 0.16]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 3.59$, df = 2 ($P = 0.17$); $I^2 = 44\%$				
Kinesiophobia_measure = TSK_Heart				
Dabek, 2020	sample_17	72	0.3%	−0.43 [−0.60; −0.22]
Dabek, 2020	sample_17	18	0.1%	−0.87 [−0.95; −0.67]
Dabek, 2020	sample_17	130	0.5%	−0.52 [−0.64; −0.39]
Dabek, 2020	sample_17	119	0.5%	−0.41 [−0.55; −0.25]
Dabek, 2020	sample_17	27	0.1%	−0.20 [−0.54; 0.19]
Dabek, 2020	sample_17	86	0.4%	−0.56 [−0.69; −0.40]
Dabek, 2020	sample_17	15	0.1%	−0.66 [−0.88; −0.23]
Total (95% CI)		**467**	**1.9%**	**−0.51 [−0.78; −0.08]**
Heterogeneity: $Tau^2 = 0.0626$; $Chi^2 = 15.47$, df = 6 ($P = 0.02$); $I^2 = 61\%$				
Kinesiophobia_measure = KCS				
Saulicz, 2016	sample_52	105	1.6%	−0.57 [−0.69; −0.42]
Kinesiophobia_measure = FActS				
Spaderna, 2020	sample_55	61	1.5%	−0.28 [−0.50; −0.03]
Kinesiophobia_measure = TSK_14				
Strandberg, 2022	sample_56	451	1.8%	−0.08 [−0.17; 0.01]
Kinesiophobia_measure = BFOMSO				
Uritani, 2020	sample_59	167	1.7%	−0.16 [−0.31; −0.01]
Kinesiophobia_measure = BBQ				
Wang , 2023	sample_60	223	1.7%	−0.35 [−0.46; −0.23]
Kinesiophobia_measure = TSK_12				
Zadro, 2019	sample_62	60	0.9%	−0.18 [−0.41; 0.08]
Total (95% CI)		**12278**	**100.0%**	**−0.19 [−0.26; −0.13]**
Prediction interval				**[−0.61; 0.30]**



Heterogeneity: $Tau^2 = 0.0634$; $Chi^2 = 564.77$, df = 82 ($P < 0.01$); $I^2 = 85\%$
Residual heterogeneity: $Tau^2 = 0.0575$; $Chi^2 = 429.28$, df = 72 ($P < 0.01$); $I^2 = 83\%$
Test for subgroup differences: F = 1.00, df = 10, 72 ($P = 0.45$)

```r
png(file = "Kinesiophobia outcome forestplot.png",
    width = 2800, height = 7000, res = 300)

forest(Kin_sub,
        layout = "RevMan5",
        sortvar = -TE,
        common = FALSE,
        xlim = c(-1.0, 0.6),
        prediction = TRUE,
        fs.hetstat = 10,
        col.subgroup = 'black',
        addrows.below.overall = 2)

dev.off()
```

```
## pdf
##   2
```

Meta-analysis: meta-regression

Meta-regression by age

```r
m.cor.reg.age <- metareg(m, ~Age)
```

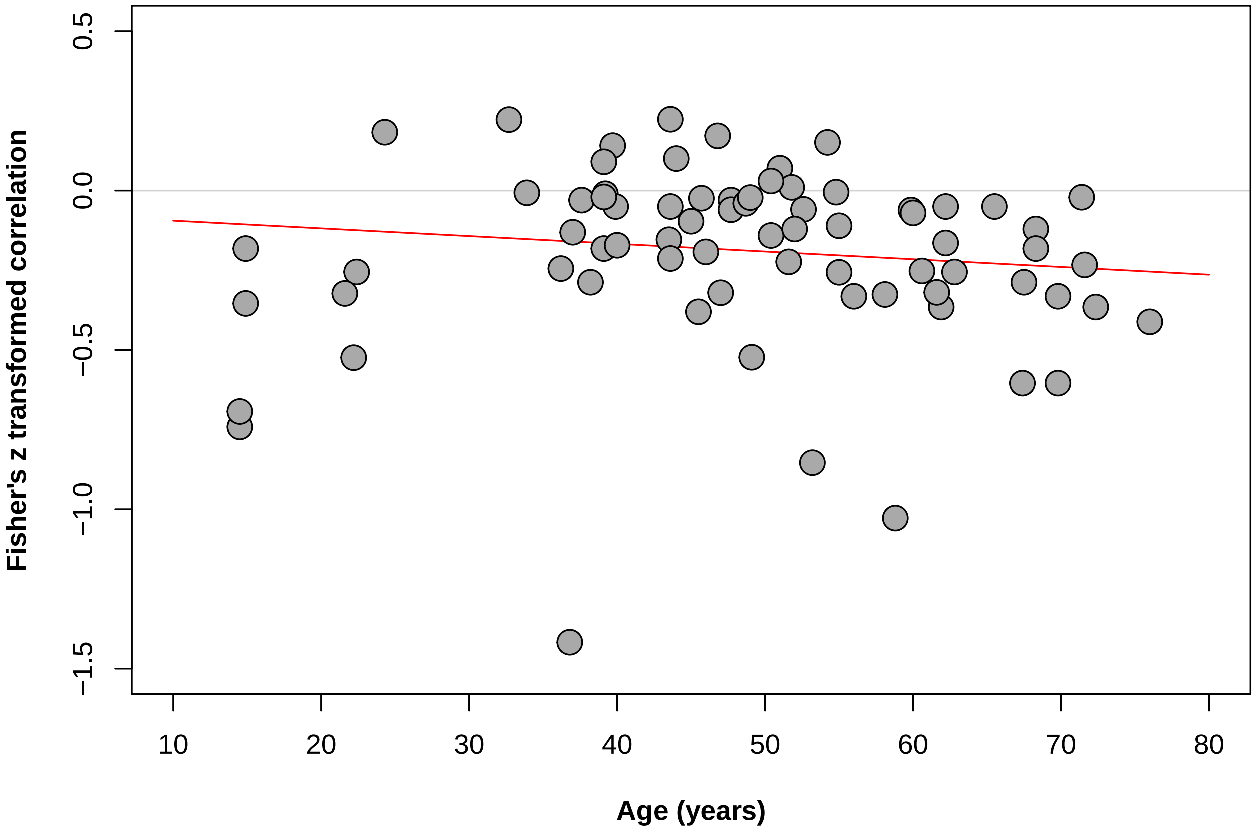
```
## Warning: 11 rows with NAs omitted from model fitting.
```

```r
m.cor.reg.age
```

```
##
## Multivariate Meta-Analysis Model (k = 72; method: REML)
##
## Variance Components:
##
##              estim    sqrt  nlvls  fixed    factor
## sigma^2.1  0.0580  0.2407     58     no        .id
## sigma^2.2  0.0033  0.0577     72     no  .id/.idx
##
## Test for Residual Heterogeneity:
## QE(df = 70) = 429.6753, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 70) = 0.8879, p-val = 0.3493
##
## Model Results:
##
##          estimate      se     tval  df    pval    ci.lb   ci.ub
## intrcpt   -0.0702  0.1323  -0.5309  70  0.5972  -0.3340  0.1936
## Age       -0.0024  0.0026  -0.9423  70  0.3493  -0.0075  0.0027
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Age did not statistically influence the correlation estimates of the meta-analysis studies (k = 72; p = 0.349).

```r
bubble(m.cor.reg.age,
       xlim = c(10, 80),
       ylim = c(-1.5, 0.5),
       xlab = 'Age (years)',
       font.lab = 2,
       studlab = FALSE, # change to TRUE for study labels
       cex = 2,
       cex.studlab = 0.6,
       pos.studlab = 1,
       offset = 0.5,
       col.line = 'red')
```



Meta-regression by proportion of women

```r
m.cor.reg.women <- metareg(m, ~Prop_women)
```

```
## Warning: 11 rows with NAs omitted from model fitting.
```

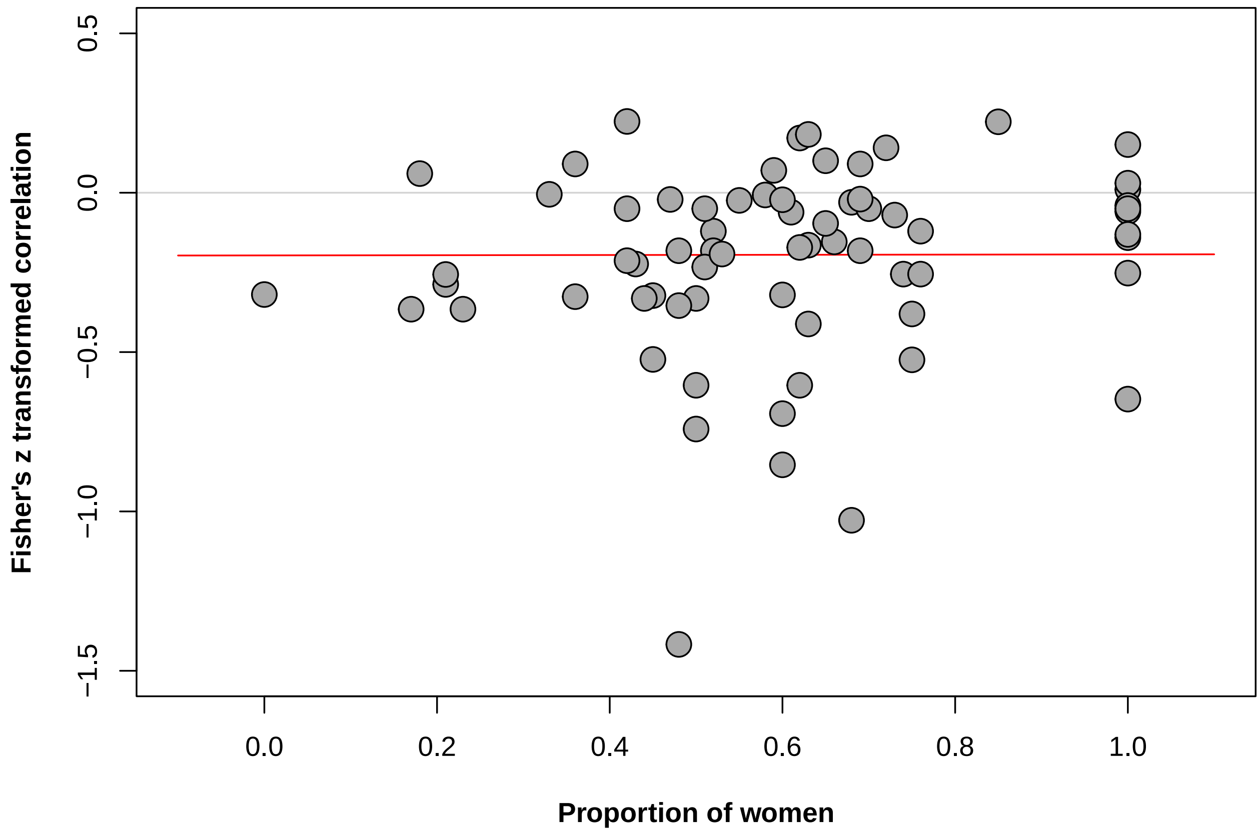
```r
m.cor.reg.women
```

```
##
## Multivariate Meta-Analysis Model (k = 72; method: REML)
##
## Variance Components:
##
##              estim    sqrt  nlvls  fixed     factor
## sigma^2.1   0.0633  0.2515     58     no        .id
## sigma^2.2   0.0043  0.0659     72     no  .id/.idx
```

```
##
## Test for Residual Heterogeneity:
## QE(df = 70) = 449.6260, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 70) = 0.3528, p-val = 0.5545
##
## Model Results:
##
##              estimate      se     tval  df    pval    ci.lb    ci.ub
## intrcpt       -0.1966  0.0380  -5.1724  70  <.0001  -0.2725  -0.1208  ***
## Prop_women     0.0031  0.0052   0.5939  70  0.5545  -0.0073   0.0135
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Similarly, the proportion of women (k = 72; p = 0.555) and the mean level of pain in the studies (k = 49; p = 0.481) did not influence correlation estimates.

```
bubble(m.cor.reg.women,
       xlim = c(-0.1, 1.1),
       ylim = c(-1.5, 0.5),
       xlab = 'Proportion of women',
       font.lab = 2,
       studlab = F,
       cex = 2,
       cex.studlab = 0.6,
       pos.studlab = 1,
       offset = 0.5,
       col.line = 'red')
```



Meta-regression by pain

```r
m.cor.reg.pain <- metareg(m, ~Pain)
```

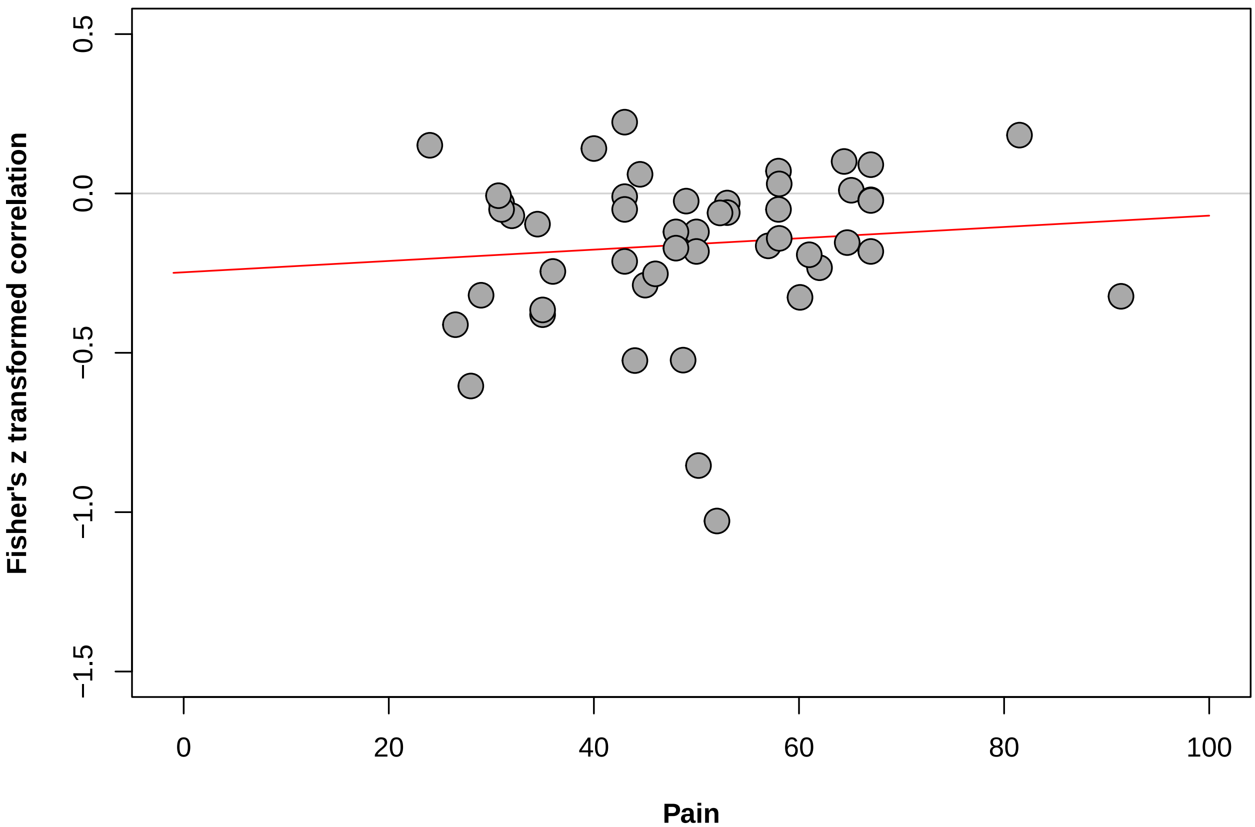
```
## Warning: 34 rows with NAs omitted from model fitting.
```

```r
m.cor.reg.pain
```

```
##
## Multivariate Meta-Analysis Model (k = 49; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed    factor
## sigma^2.1  0.0435  0.2085     41     no       .id
## sigma^2.2  0.0012  0.0349     49     no  .id/.idx
##
## Test for Residual Heterogeneity:
## QE(df = 47) = 274.6816, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 47) = 0.5039, p-val = 0.4813
##
## Model Results:
##
##          estimate      se     tval  df    pval    ci.lb   ci.ub
## intrcpt   -0.2473  0.1285  -1.9252  47  0.0603  -0.5058  0.0111  .
## Pain       0.0018  0.0025   0.7098  47  0.4813  -0.0033  0.0068
```

```
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
bubble(m.cor.reg.pain,
       xlim = c(-1, 100),
       ylim = c(-1.5, 0.5),
       xlab = 'Pain',
       studlab = FALSE,
       font.lab = 2,
       cex = 2,
       cex.studlab = 0.6,
       pos.studlab = 1,
       offset = 0.5,
       col.line = 'red')
```



Sensitivity analysis: meta-regression by axis score

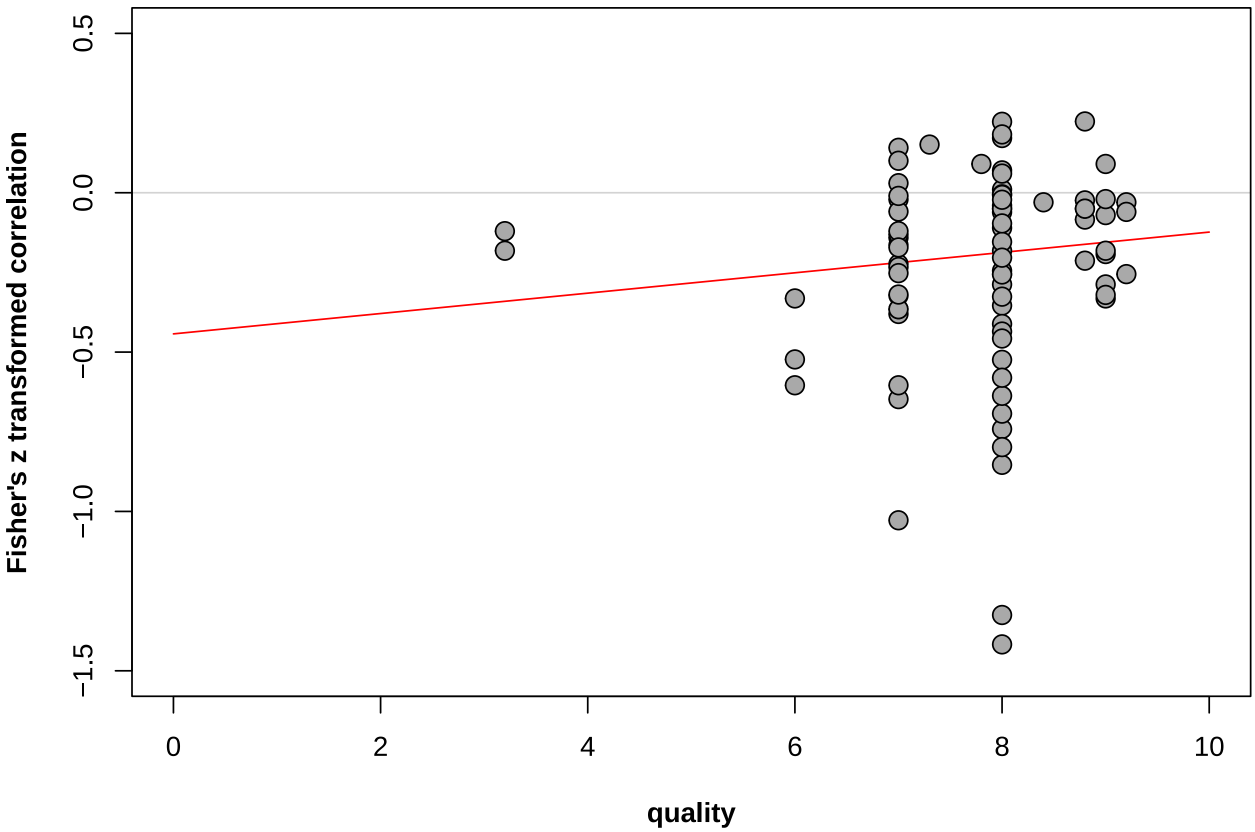
```
m.cor.reg.axis <- metareg(m, ~quality)
m.cor.reg.axis
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
## Variance Components:
##
##               estim    sqrt  nlvls  fixed    factor
```

```
## sigma^2.1  0.0582  0.2412     63     no       .id
## sigma^2.2  0.0057  0.0754     83     no  .id/.idx
##
## Test for Residual Heterogeneity:
## QE(df = 81) = 544.5239, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 81) = 0.8018, p-val = 0.3732
##
## Model Results:
##
##          estimate      se     tval  df    pval    ci.lb   ci.ub
## intrcpt   -0.4429  0.2783  -1.5914  81  0.1154  -0.9966  0.1108
## quality    0.0319  0.0357   0.8954  81  0.3732  -0.0390  0.1029
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

A study's quality score ($k = 83$) did not influence correlation values ($p = 0.3732$).

```r
bubble(m.cor.reg.axis,
       xlim = c(0, 10),
       ylim = c(-1.5, 0.5),
       xlab = 'quality',
       studlab = FALSE,
       font.lab = 2,
       cex = 1.5,
       cex.studlab = 0.6,
       pos.studlab = 1,
       offset = 0.5,
       col.line = 'red')
```

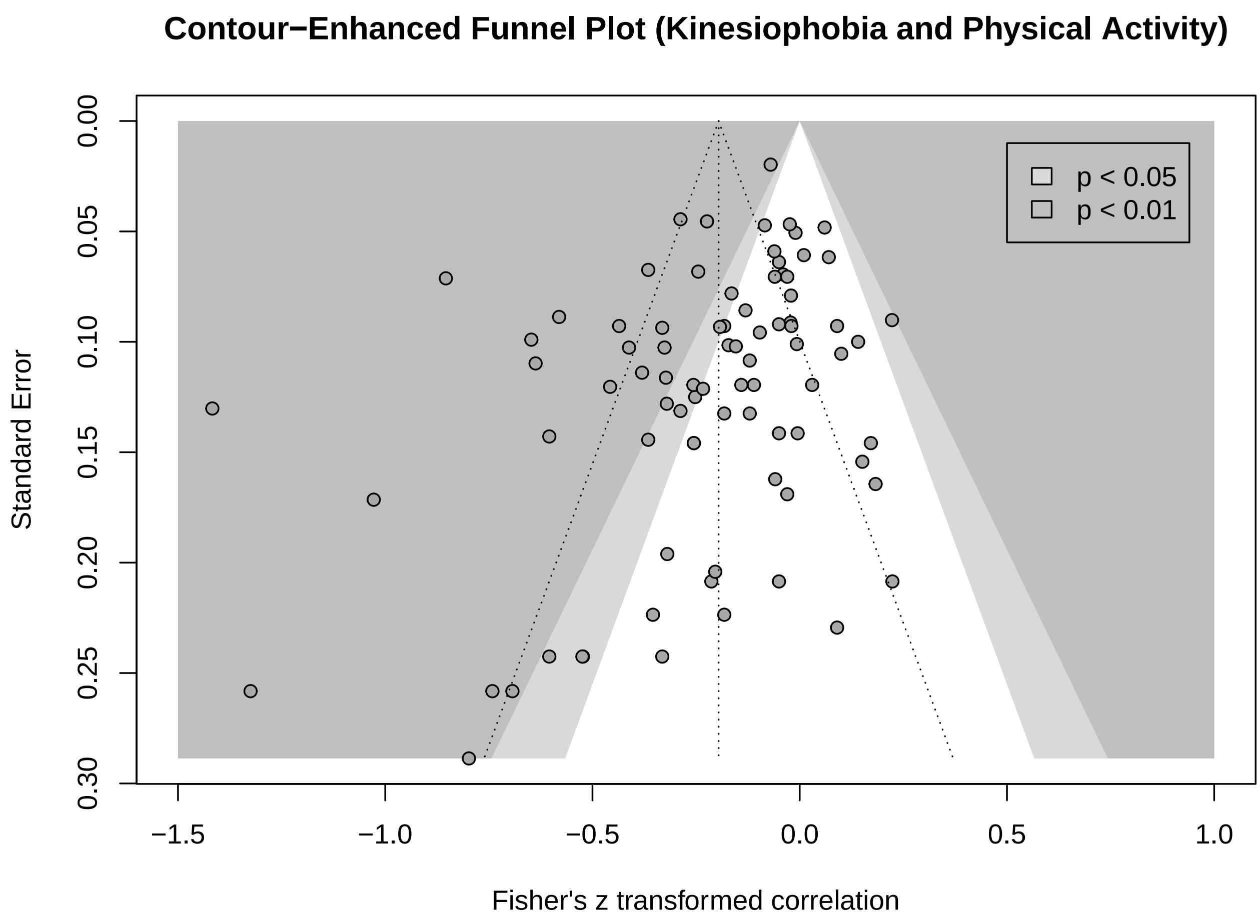


Publication bias analysis

Small-study effects

Funnel plot

```
# Define fill colors for contour
col.contour = c("gray85", "gray75")

# Funnel plot
meta::funnel(m,
             xlim = c(-1.5, 1),
             contour = c(0.95, 0.99),
             col.contour = col.contour)

# legend
legend(x =0.5, y = 0.01,
       legend = c("p < 0.05", "p < 0.01"),
       fill = col.contour)

# title
title("Contour-Enhanced Funnel Plot (Kinesiophobia and Physical Activity)")
```




```r
png(file = "Funnel Plot.png", width = 2500, height = 2000, res = 300)

# Define fill colors for contour
col.contour = c("gray85", "gray75")

# Funnel plot
meta::funnel(m,
             xlim = c(-1.5, 1),
             contour = c(0.95, 0.99),
             col.contour = col.contour)

# legend
legend(x =0.5, y = 0.01,
       legend = c("p < 0.05", "p < 0.01"),
       fill = col.contour)

# title
title("Contour-Enhanced Funnel Plot (Kinesiophobia and Physical Activity)")

dev.off()
```

```
## pdf
##   2
```

Egger's test

There is no direct function to conduct Egger's test for multi-level model. Alternatively, we calculate it by using the standard errors of the effect size estimates as a predictor in the meta-regression. (see: https://rstudio-pubs-static.s3.amazonaws.com/814435_6401e0cceb0b410c8208642dc5ee07f0.html)

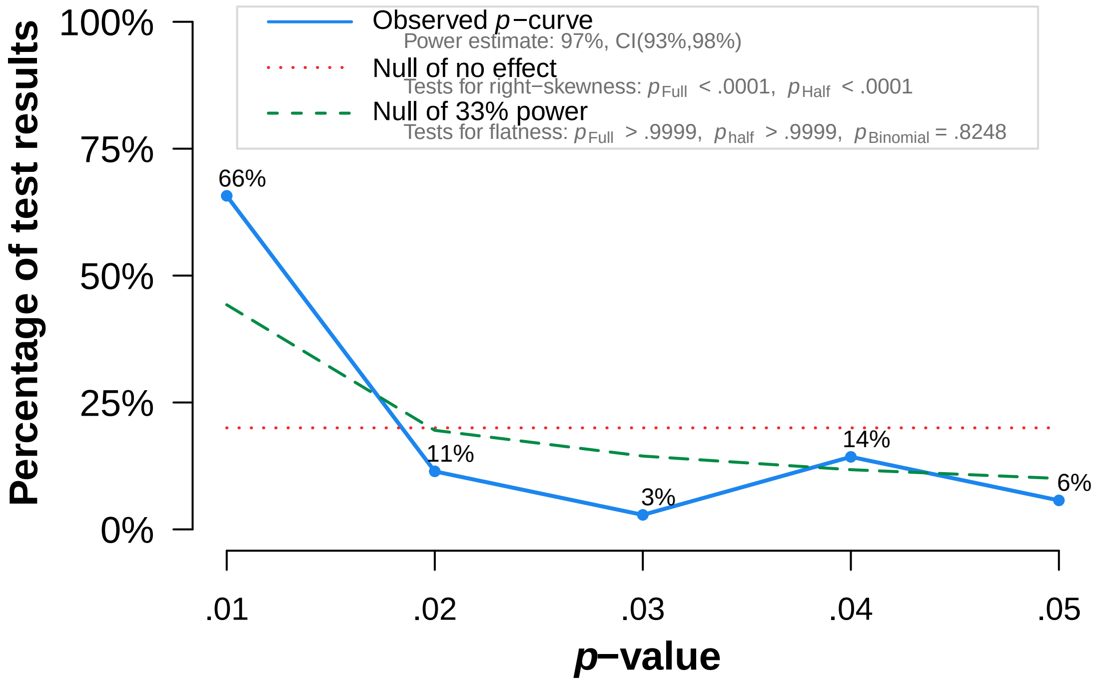
```
test.egger = rma.mv(z,var.z, mod = ~ sqrt(var.z), random =  ~ 1 | author/cor_id, data = Kinphob_r, test
test.egger
```

```
##
## Multivariate Meta-Analysis Model (k = 83; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed         factor
## sigma^2.1  0.0534  0.2312     63     no         author
## sigma^2.2  0.0060  0.0772     83     no  author/cor_id
##
## Test for Residual Heterogeneity:
## QE(df = 81) = 506.5963, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 81) = 7.0537, p-val = 0.0095
##
## Model Results:
##
##              estimate      se     tval  df    pval    ci.lb    ci.ub
## intrcpt       -0.0333  0.0695  -0.4799  81  0.6326  -0.1716   0.1049
## sqrt(var.z)   -1.4968  0.5636  -2.6559  81  0.0095  -2.6181  -0.3754  **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Egger's regression test using the standard errors of the effect size estimates as a predictor in the meta-regression showed that the coefficient of the standard error was significant ($b = -1.497$, 95% CI: -2.618 to -0.3754, $p = 0.0095$), suggesting that the data in the funnel plot was asymmetrical. This asymmetry may be explained by publication bias, but also by other potential causes, such as different study procedures and between-study heterogeneity, which was substantial-to-considerable here.

Pcurve analysis

```
pcurve(m, effect.estimation = FALSE, N, dmin = 0, dmax = 1)
```



Note: The observed p−curve includes 35 statistically significant (p < .05) results, of which 27 are p < .025.
There were 48 additional results entered but excluded from p−curve because they were p > .05.

```
## P-curve analysis
##  -----------------------
## - Total number of provided studies: k = 83
## - Total number of p<0.05 studies included into the analysis: k = 35 (42.17%)
## - Total number of studies with p<0.025: k = 27 (32.53%)
##
## Results
##  -----------------------
##                     pBinomial   zFull pFull   zHalf pHalf
## Right-skewness test     0.001 -13.811     0 -15.583     0
## Flatness test           0.825   9.421     1  14.677     1
## Note: p-values of 0 or 1 correspond to p<0.001 and p>0.999, respectively.
## Power Estimate: 97% (93.4%-98.5%)
##
## Evidential value
##  -----------------------
## - Evidential value present: yes
## - Evidential value absent/inadequate: no
```

The 83 Pearson's r correlation values were provided to the p-curve analysis. The observed p-curve included 35 statistically significant ($p < 0.05$), 27 of which were highly significant ($p < 0.025$), and was visually right-skewed. The other results were excluded because they had a $p > 0.05$. The p-value of the right-skewness test was < 0.001 for both the half curve (curve of p values 0.025) and the full curve (curve of p values $<$ 0.05), confirming that the p-curve was right-skewed and suggesting that the effect of our meta-analysis is true, i.e., that the effect we estimated is not an artifact caused by selective reporting (e.g., p-hacking) in the literature 120. In addition, the statistical power of the studies that were included in the p-curve analysis was 97% (90% CI: 93 to 98%), suggesting that approximately 90% of the significant results are expected to be replicable.

References

- Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed.; 1988.

- Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997;315(7109):629-634. https://doi.org/10.1136/bmj.315.7109.62

- Higgins JPT, Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med. 2002;21(11):1539-1558. https://doi.org/10.1002/sim.1186
- Knapp G, Hartung J. Improved tests for a random effects meta-regression with a single covariate. Stat Med. 2003;22(17):2693-2710. https://doi.org/10.1002/sim.1482

- R Core Team. R: A language and environment for statistical computing [Computer software]. Version 4.3.1. Vienna, Austria: Foundation for Statistical Computing; 2023. https://www.r-project.org
- Schwarzer G. Meta: General package for meta-analysis [R package]. Version 6.5-0; 2023. https://cran.r-project.org/web/packages/meta/meta.pdf
- Schwarzer G, Carpenter RJ, Rücker G. Metasens: Advanced statistical methods to model and adjust for bias in meta-analysis [R package]. Version 1.5-2; 2023. https://cran.r-project.org/web/packages/metasens/metasens.pdf

- Simonsohn U, Nelson LD, Simmons JP. P-curve: A key to the file-drawer. J Exp Psychol Gen. 2014;143(2):534-547. http://doi.org/10.1037/a0033242

- Viechtbauer W. Bias and efficiency of meta-analytic variance estimators in the random-effects model. J Educ Behav Stat. 2005;30(3):261-293. https://doi.org/10.3102/10769986030003261

- Viechtbauer W. Conducting meta-analyses in R with the metafor package. J Stat Softw. 2010;36(3):1-48. https://doi.org/10.18637/jss.v036.i03

- Viechtbauer W. Metafor: Meta-analysis package for R [R package]. Version 4.2-0; 2023. https://cran.r-pro-ject.org/web/packages/metafor/metafor.pdf

- Viechtbauer, “W. (2023). Metafor: Meta-Analysis Package for R (Version 4.2-0) [R pakage]. https://cran.r-project.org/web/packages/metafor/metafor.pdf