

```

library(metafor)
library(metaSEM)
library(readxl)

my_data <- read_excel("Personality_traits_anxious_perpetration.xls")
dataset <- as.data.frame(my_data)
Step1 <- rma.mv(yi=r, V=inv_n,
               data=dataset,
               random=list(~1|studyID,~1|ESID),
               method="ML", mods=~factor(Cell)-1)
summary (Step1)

##
## Multivariate Meta-Analysis Model (k = 120; method: ML)
##
##      logLik   Deviance      AIC      BIC      AICc
##  91.0831   246.0483  -172.1662  -158.2288  -171.6399
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed  factor
## sigma^2.1 0.0066 0.0812    9    no  studyID
## sigma^2.2 0.0062 0.0786   120    no    ESID
##
## Test for Residual Heterogeneity:
## QE(df = 117) = 410.0650, p-val < .0001
##
## Test of Moderators (coefficients 1:3):
## QM(df = 3) = 135.1675, p-val < .0001
##
## Model Results:
##
##      estimate      se      zval      pval      ci.lb      ci.ub
## factor(Cell)1  0.2427  0.0355   6.8342 <.0001  0.1731  0.3123 ***
## factor(Cell)2  0.1737  0.0333   5.2142 <.0001  0.1084  0.2389 ***
## factor(Cell)3  0.3437  0.0329  10.4611 <.0001  0.2793  0.4082 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

Acov_UnadjES <- Step1$vb
Matrix_UnadjES <- vec2symMat(c(1,Step1$b[1],Step1$b[2],
                              1,Step1$b[3],
                              1),
                             diag = TRUE)
varnames <- c("Attachment", "Personality","IPV")
colnames(Matrix_UnadjES) <- varnames
rownames(Matrix_UnadjES) <- varnames
model <- "IPV ~ c*Attachment + b*Personality
         Personality ~ a*Attachment
         Attachment ~~ 1*Attachment"
RAM1 <- lavaan2RAM(model, obs.variables = varnames)
A <- RAM1$A

```

```

S <-RAM1$$
n <- 1712
unadjusted.metaSEM <- wls(Cov=Matrix_UnadjES,aCov=Acov_UnadjES,n=n,
                          Amatrix=A,Smatrix=S,cor.analysis=TRUE,
                          diag.constraints=FALSE,
                          intervals.type = "LB",
                          mx.algebras = list(Indirect=mxAlgebra(a*b, name="Indirect"),
                                              Direct=mxAlgebra(c, name="Direct")))
summary(unadjusted.metaSEM)

```

```

##
## Call:
## wls(Cov = Matrix_UnadjES, aCov = Acov_UnadjES, n = n, Amatrix = A,
##      Smatrix = S, diag.constraints = FALSE, cor.analysis = TRUE,
##      intervals.type = "LB", mx.algebras = list(Indirect = mxAlgebra(a *
##      b, name = "Indirect"), Direct = mxAlgebra(c, name = "Direct")))
##
## 95% confidence intervals: Likelihood-based statistic
## Coefficients:
##   Estimate Std.Error  lbound  ubound z value Pr(>|z|)
## c 0.095882      NA 0.049465 0.142059      NA      NA
## b 0.320478      NA 0.265000 0.375733      NA      NA
## a 0.242688      NA 0.172999 0.312348      NA      NA
##
## mxAlgebras objects (and their 95% likelihood-based CIs):
##           lbound  Estimate  ubound
## Indirect[1,1] 0.04813632 0.07777642 0.1136069
## Direct[1,1]   0.04946458 0.09588177 0.1420595
##
## Goodness-of-fit indices:
##
##                                     Value
## Sample size                          1712.00
## Chi-square of target model              0.00
## DF of target model                      0.00
## p value of target model                 0.00
## Number of constraints imposed on "Smatrix" 0.00
## DF manually adjusted                    0.00
## Chi-square of independence model        135.17
## DF of independence model                 3.00
## RMSEA                                  0.00
## RMSEA lower 95% CI                      0.00
## RMSEA upper 95% CI                      0.00
## SRMR                                    0.00
## TLI                                     -Inf
## CFI                                     1.00
## AIC                                     0.00
## BIC                                     0.00
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values indicate problems.)

```

```

#unadjusted.metaSEM<-rerun(unadjusted.metaSEM, autofixtau2 = TRUE)
summary(unadjusted.metaSEM)

```

```

##
## Call:
## wls(Cov = Matrix_UnadjES, aCov = Acov_UnadjES, n = n, Amatrix = A,
##     Smatrix = S, diag.constraints = FALSE, cor.analysis = TRUE,
##     intervals.type = "LB", mx.algebras = list(Indirect = mxAlgebra(a *
##         b, name = "Indirect"), Direct = mxAlgebra(c, name = "Direct")))
##
## 95% confidence intervals: Likelihood-based statistic
## Coefficients:
##   Estimate Std.Error   lbound   ubound z value Pr(>|z|)
## c 0.095882      NA 0.049465 0.142059   NA     NA
## b 0.320478      NA 0.265000 0.375733   NA     NA
## a 0.242688      NA 0.172999 0.312348   NA     NA
##
## mxAlgebras objects (and their 95% likelihood-based CIs):
##           lbound Estimate   ubound
## Indirect[1,1] 0.04813632 0.07777642 0.1136069
## Direct[1,1]   0.04946458 0.09588177 0.1420595
##
## Goodness-of-fit indices:
##                                     Value
## Sample size                          1712.00
## Chi-square of target model            0.00
## DF of target model                    0.00
## p value of target model                0.00
## Number of constraints imposed on "Smatrix" 0.00
## DF manually adjusted                  0.00
## Chi-square of independence model       135.17
## DF of independence model               3.00
## RMSEA                                 0.00
## RMSEA lower 95% CI                    0.00
## RMSEA upper 95% CI                    0.00
## SRMR                                  0.00
## TLI                                   -Inf
## CFI                                   1.00
## AIC                                    0.00
## BIC                                    0.00
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values indicate problems.)

## Testing the hypothesis  $c = a*b$ 
stage2b <- wls(Cov=Matrix_UnadjES,aCov=Acov_UnadjES,n=n,
              Amatrix=A,Smatrix=S,cor.analysis=TRUE,diag.constraints=FALSE,
              intervals.type = "LB",
              mx.algebras = list(Indirect=mxAlgebra(a*b, name="Indirect"),
                                Direct=mxAlgebra(c, name="Direct")), run=FALSE)

## Add a constraint on  $c=a*b$ 
## Rerun to remove errors
stage2b <- mxModel(stage2b, mxConstraint(c==a*b, name="constraint"))
stage2b <- mxRun(stage2b)
# stage2b <- mxTryHard(stage2b, extraTries = 100)
stage2b <- mxRun(stage2b, intervals = TRUE)
summary(stage2b)

```

```

## Summary of WLS Correlation
##
## free parameters:
##   name matrix      row      col Estimate Std.Error A
## 1   a Amatrix Personality Attachment 0.25324009 0.03305412 !
## 2   c Amatrix      IPV Attachment 0.08288641 0.01609585 !
## 3   b Amatrix      IPV Personality 0.32730366 0.02739620 !
##
## confidence intervals:
##
##           lbound estimate ubound note
## a           0.18451416 0.25324009 0.3170995
## c           0.05187723 0.08288641 0.1159575
## b           0.27008760 0.32730366 0.3796956
## WLS Correlation.Indirect[1,1] 0.05185745 0.08288641 0.1158448
## WLS Correlation.Direct[1,1]   0.05187723 0.08288641 0.1159575
##
## Model Statistics:
##           | Parameters | Degrees of Freedom | Fit (-2lnL units)
##           |-----|-----|-----|-----|
## Model:           3                -2                0.576945
## Saturated:       NA                NA                NA
## Independence:    NA                NA                NA
## Number of observations/statistics: 0/1
##
## Constraint 'constraint' contributes 1 observed statistic.
##
## Information Criteria:
##           | df Penalty | Parameters Penalty | Sample-Size Adjusted
## AIC:           NA                NA                NA
## BIC:           NA                NA                NA
## CFI: NA
## TLI: 1 (also known as NNFI)
## RMSEA: 0 [95% CI (NA, NA)]
## Prob(RMSEA <= 0.05): NA
## To get additional fit indices, see help(mxRefModels)
## timestamp: 2022-06-14 14:45:46
## Wall clock time: 0.09860349 secs
## optimizer: SLSQP
## OpenMx version number: 2.20.6
## Need help? See help(mxSummary)

```

```
summary(stage2b, verbose=T)
```

```

## Summary of WLS Correlation
##
## free parameters:
##   name matrix      row      col Estimate Std.Error A lbound ubound
## 1   a Amatrix Personality Attachment 0.25324009 0.03305412 !
## 2   c Amatrix      IPV Attachment 0.08288641 0.01609585 !
## 3   b Amatrix      IPV Personality 0.32730366 0.02739620 !
##
## confidence intervals:
##
##           lbound estimate ubound note
## a           0.18451416 0.25324009 0.3170995
## c           0.05187723 0.08288641 0.1159575

```

```

## b                0.27008760 0.32730366 0.3796956
## WLS Correlation.Indirect[1,1] 0.05185745 0.08288641 0.1158448
## WLS Correlation.Direct[1,1]   0.05187723 0.08288641 0.1159575
##
## CI details:
##
##           parameter side      value      fit diagnostic
## 1                a lower 0.18451416 4.418829      success
## 2                a upper 0.31709952 4.434502      success
## 3                c lower 0.05187723 4.427828      success
## 4                c upper 0.11595747 4.455380      success
## 5                b lower 0.27008760 4.423101      success
## 6                b upper 0.37969559 4.425518      success
## 7 WLS Correlation.Indirect[1,1] lower 0.05185745 4.434337      success
## 8 WLS Correlation.Indirect[1,1] upper 0.11584479 4.422663      success
## 9   WLS Correlation.Direct[1,1] lower 0.05187723 4.427828      success
## 10  WLS Correlation.Direct[1,1] upper 0.11595747 4.455380      success
##   statusCode      method      a      c      b
## 1             OK neale-miller-1997 0.1845142 0.05294890 0.2869637
## 2             OK neale-miller-1997 0.3170995 0.11291761 0.3561080
## 3             OK neale-miller-1997 0.1871083 0.05187723 0.2772499
## 4             OK neale-miller-1997 0.3114234 0.11595747 0.3723339
## 5             OK neale-miller-1997 0.2058274 0.05558985 0.2700876
## 6             OK neale-miller-1997 0.2897105 0.10999869 0.3796956
## 7             OK neale-miller-1997 0.1866627 0.05185452 0.2778137
## 8             OK neale-miller-1997 0.3122138 0.11584284 0.3710432
## 9             OK neale-miller-1997 0.1871083 0.05187723 0.2772499
## 10            OK neale-miller-1997 0.3114234 0.11595747 0.3723339
##
## Model Statistics:
##           | Parameters | Degrees of Freedom | Fit (-2lnL units)
## Model:    |         3 |                   -2 |          0.576945
## Saturated: |        NA |                   NA |          NA
## Independence: |       NA |                   NA |          NA
## Number of observations/statistics: 0/1
##
## Constraint 'constraint' contributes 1 observed statistic.
##
## maximum absolute gradient: 62.93901 ( c )
## chi-square:  2 ( df=NA ) = NA, p = NA
## Information Criteria:
##           | df Penalty | Parameters Penalty | Sample-Size Adjusted
## AIC:      |         NA |                 NA |          NA
## BIC:      |         NA |                 NA |          NA
## CFI: NA
## TLI: 1    (also known as NNFI)
## RMSEA: 0 [95% CI (NA, NA)]
## Prob(RMSEA <= 0.05): NA
## To get additional fit indices, see help(mxRefModels)
## timestamp: 2022-06-14 14:45:46
## frontend time: 0.07907319 secs
## backend time: 0.01951313 secs
## independent submodels time: 1.716614e-05 secs
## cpu time: 0.09860349 secs
## Wall clock time: 0.09860349 secs

```

```
## OpenMx version number: 2.20.6
## Need help? See help(mxSummary)
```

```
anova(unadjusted.metaSEM$mx.fit, stage2b)
```

```
##           base      comparison ep      minus2LL df      AIC      diffLL diffdf
## 1 WLS Correlation      <NA> 3 1.28621e-23 -3 6.000000      NA      NA
## 2 WLS Correlation WLS Correlation 3 5.76945e-01 -2 6.576945 0.576945      1
##           p
## 1      NA
## 2 0.4475123
```

```
sessionInfo()
```

```
## R version 4.2.0 (2022-04-22)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04.4 LTS
##
## Matrix products: default
## BLAS: /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.9.0
## LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.9.0
##
## locale:
## [1] LC_CTYPE=en_SG.UTF-8      LC_NUMERIC=C
## [3] LC_TIME=en_SG.UTF-8      LC_COLLATE=en_SG.UTF-8
## [5] LC_MONETARY=en_SG.UTF-8  LC_MESSAGES=en_SG.UTF-8
## [7] LC_PAPER=en_SG.UTF-8     LC_NAME=C
## [9] LC_ADDRESS=C             LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_SG.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats      graphics  grDevices  utils      datasets  methods   base
##
## other attached packages:
## [1] readxl_1.4.0 metaSEM_1.2.6 OpenMx_2.20.6 metafor_3.4-0 metadat_1.2-0
## [6] Matrix_1.4-1
##
## loaded via a namespace (and not attached):
## [1] Rcpp_1.0.8.3      pillar_1.7.0      compiler_4.2.0    cellranger_1.1.0
## [5] mathjaxr_1.6-0    tools_4.2.0       digest_0.6.29     tibble_3.1.7
## [9] evaluate_0.15     lifecycle_1.0.1   nlme_3.1-157      lattice_0.20-45
## [13] pkgconfig_2.0.3  rlang_1.0.2       cli_3.3.0         rstudioapi_0.13
## [17] yaml_2.3.5        parallel_4.2.0    mvtnorm_1.1-3     pbivnorm_0.6.0
## [21] xfun_0.31         fastmap_1.1.0     stringr_1.4.0     knitr_1.39
## [25] vctr_0.4.1        stats4_4.2.0      grid_4.2.0        glue_1.6.2
## [29] ellipse_0.4.2    fansi_1.0.3       rmarkdown_2.14    lavaan_0.6-11
## [33] magrittr_2.0.3    ellipsis_0.3.2    htmltools_0.5.2   MASS_7.3-57
## [37] mnormt_2.0.2     utf8_1.2.2        stringi_1.7.6     RcppParallel_5.1.5
## [41] tmvnsim_1.0-2    crayon_1.5.1
```