cca_paper_example

7/6/2020

Load packages and Data set

```
## Loading required package: Matrix
```

```
## Loading 'metafor' package (version 2.4-0). For an overview
## and introduction to the package please type: help(metafor).
```

```
## Loading required package: OpenMx
```

```
## OpenMx may run faster if it is compiled to take advantage of multiple cores.
```

```
##
## Attaching package: 'OpenMx'
```

```
## The following objects are masked from 'package:Matrix':
##
##     %&%, expm
```

```
## "SLSQP" is set as the default optimizer in OpenMx.
```

```
## mxOption(NULL, "Gradient algorithm") is set at "central".
```

```
## mxOption(NULL, "Optimality tolerance") is set at "6.3e-14".
```

```
## mxOption(NULL, "Gradient iterations") is set at "2".
```

Subset of the data

```
#Subset of variables needed for the analyses:
data_adt_cca<- data_adt[c("studyid", "es_g","se_g","g1hrsperweek","g1txdays","g2hrsperweek","g2txdays" ]

#Visualize missingness
source("../code/wrappers.R")
```

```
## -- Attaching packages ---------------------------------------------------------------------- tidy
```

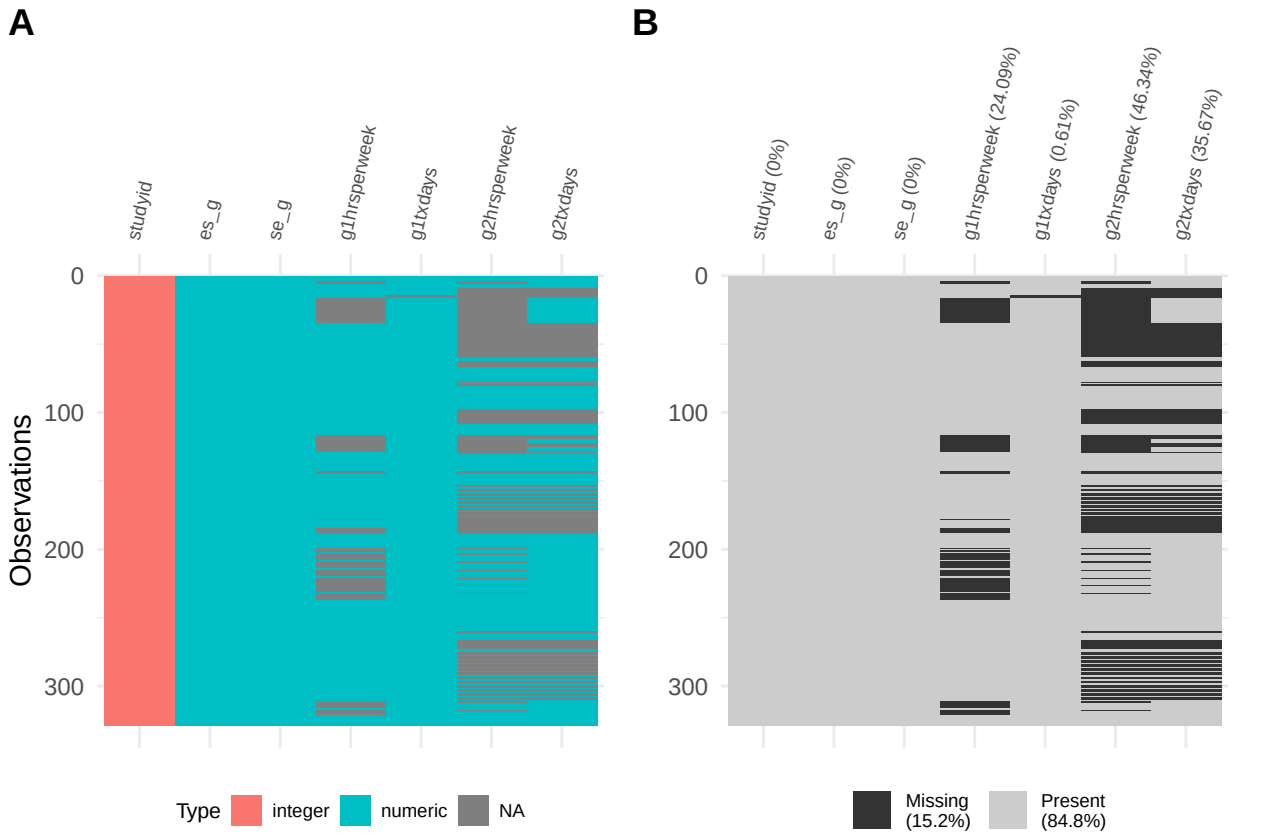
```
## v tibble  3.0.3     v dplyr   1.0.2
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.0
## v purrr   0.3.4
```

```
## -- Conflicts ------------------------------------------------------------------------- tidyverse_
## x tidyr::expand() masks Matrix::expand()
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## x tidyr::pack()   masks Matrix::pack()
## x purrr::rerun()  masks metaSEM::rerun()
## x tidyr::unpack() masks Matrix::unpack()
```

```
##
## Attaching package: 'gridExtra'
```

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
gg_summary_covariate_miss(data_adt_cca)
```




```
data.frame(k.NA=colSums(is.na(data_adt_cca)))
```

```
##              k.NA
## studyid         0
## es_g            0
## se_g            0
## g1hrsperweek   79
## g1txdays        2
## g2hrsperweek  152
## g2txdays      117
```

```
table(rowSums(is.na(data_adt_cca)))
```

```
##
##   0   1   2   3
## 144  32 138  14
```

```
#Percentage missing by variable
miss_var_summary(data_adt_cca)
```

```
## # A tibble: 7 x 3
##   variable     n_miss pct_miss
##   <chr>         <int>    <dbl>
## 1 g2hrsperweek    152   46.3
```

```
## 2 g2txdays        117   35.7
## 3 g1hrsperweek     79   24.1
## 4 g1txdays          2    0.610
## 5 studyid           0    0
## 6 es_g              0    0
## 7 se_g              0    0
```

```
#Percentage missing by Effect Size case
miss_case_summary(data_adt_cca)
```

```
## # A tibble: 328 x 3
##     case n_miss pct_miss
##    <int>  <int>    <dbl>
##  1    15      3     42.9
##  2    16      3     42.9
##  3   117      3     42.9
##  4   118      3     42.9
##  5   119      3     42.9
##  6   123      3     42.9
##  7   124      3     42.9
##  8   125      3     42.9
##  9   143      3     42.9
## 10   144      3     42.9
## # ... with 318 more rows
```

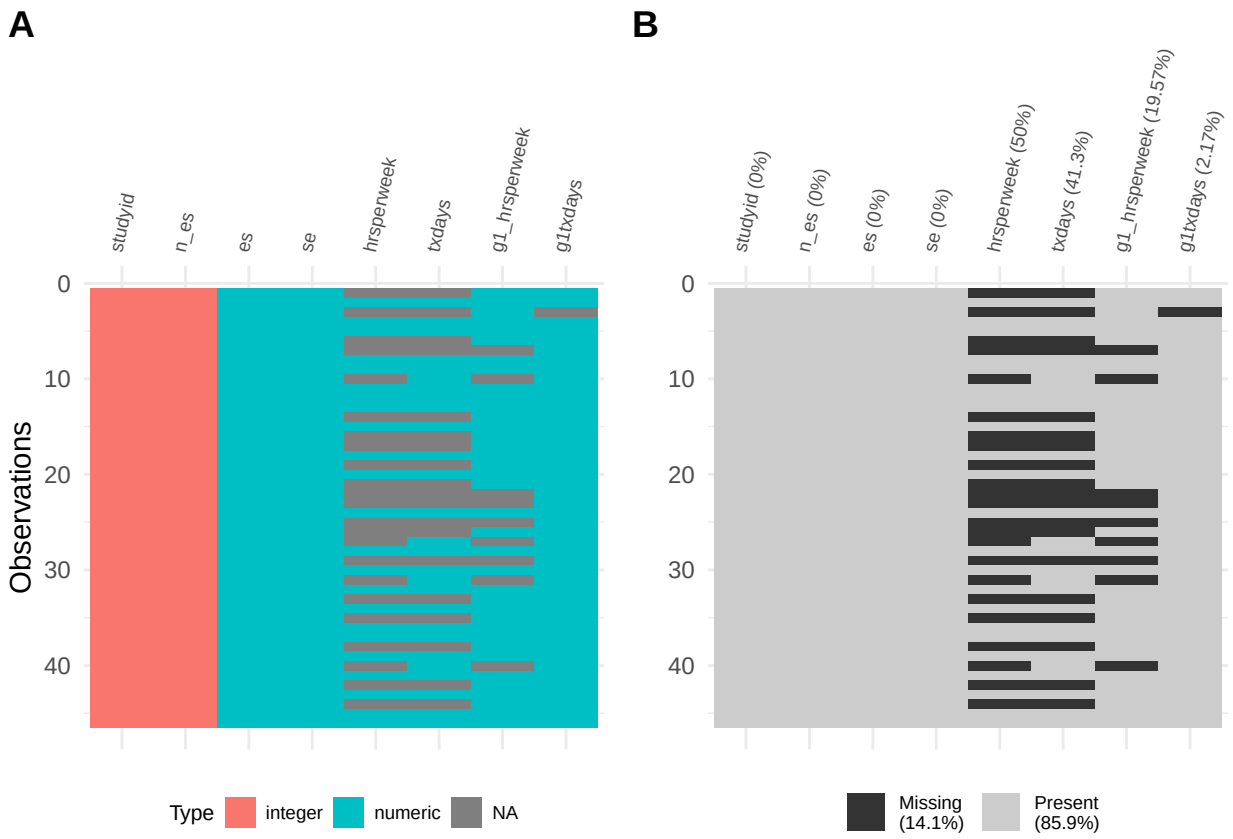
Reduce to one ES per study

```
#Difference between g1 and g2
data_adt_cca$diff_hrsperweek= data_adt_cca$g1hrsperweek - data_adt_cca$g2hrsperweek
data_adt_cca$diff_txdays= data_adt_cca$g1txdays - data_adt_cca$g2txdays

#New dataset with mean
data_agregated<- data_adt_cca %>% group_by(studyid) %>%
                                  summarise (n_es= n(),
                                             es= mean(es_g),
                                             se= mean(se_g),
                                             hrsperweek = mean(diff_hrsperweek),
                                             txdays= mean(diff_txdays),
                                             g1_hrsperweek= mean(g1hrsperweek),
                                             g1txdays= mean(g1txdays))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
#Missing covariates within new dataset
gg_summary_covariate_miss(data_agregated)
```



Complete case analysis

```
#Complete case analysis using g1 only
rma_cca<- rma(es, se^2, mod= ~ g1_hrsperweek + g1txdays, data=data_agregated)
```

```
## Warning in rma(es, se^2, mod = ~g1_hrsperweek + g1txdays, data =
## data_agregated): Studies with NAs omitted from model fitting.
```

```
rma_cca
```

```
##
## Mixed-Effects Model (k = 36; tau^2 estimator: REML)
##
## tau^2 (estimated amount of residual heterogeneity):     0.0384 (SE = 0.0229)
## tau (square root of estimated tau^2 value):             0.1960
## I^2 (residual heterogeneity / unaccounted variability): 43.16%
## H^2 (unaccounted variability / sampling variability):   1.76
## R^2 (amount of heterogeneity accounted for):            3.96%
##
## Test for Residual Heterogeneity:
## QE(df = 33) = 61.8036, p-val = 0.0017
##
## Test of Moderators (coefficients 2:3):
## QM(df = 2) = 3.6118, p-val = 0.1643
##
## Model Results:
##
##                estimate      se     zval    pval    ci.lb   ci.ub
```

```
## intrcpt          0.1895  0.1244   1.5236  0.1276  -0.0543  0.4333
## g1_hrsperweek    0.0648  0.0372   1.7411  0.0817  -0.0081  0.1378  .
## g1txdays        -0.0009  0.0011  -0.8876  0.3748  -0.0030  0.0011
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Complete case analysis using diff g1-g2
rma_cca_diff<- rma(es, se^2, mod= ~ hrsperweek + txdays, data=data_agregated)
```

```
## Warning in rma(es, se^2, mod = ~hrsperweek + txdays, data = data_agregated):
## Studies with NAs omitted from model fitting.
```

```
rma_cca_diff
```

```
##
## Mixed-Effects Model (k = 23; tau^2 estimator: REML)
##
## tau^2 (estimated amount of residual heterogeneity):     0.0709 (SE = 0.0415)
## tau (square root of estimated tau^2 value):             0.2662
## I^2 (residual heterogeneity / unaccounted variability): 58.33%
## H^2 (unaccounted variability / sampling variability):   2.40
## R^2 (amount of heterogeneity accounted for):            0.00%
##
## Test for Residual Heterogeneity:
## QE(df = 20) = 49.6686, p-val = 0.0002
##
## Test of Moderators (coefficients 2:3):
## QM(df = 2) = 1.8264, p-val = 0.4012
##
## Model Results:
##
##             estimate      se    zval    pval    ci.lb   ci.ub
## intrcpt       0.1494  0.0836  1.7863  0.0740  -0.0145  0.3133  .
## hrsperweek    0.2021  0.1495  1.3513  0.1766  -0.0910  0.4951
## txdays        0.0066  0.0230  0.2869  0.7742  -0.0385  0.0518
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Shifting units of analysis

```
#Using g1 only
#Covariate 1: g1hrsperweek
rma_suoa_1<- rma(es, se^2, mod= ~ g1_hrsperweek, data=data_agregated)
```

```
## Warning in rma(es, se^2, mod = ~g1_hrsperweek, data = data_agregated): Studies
## with NAs omitted from model fitting.
```

```
rma_suoa_1
```

```
##
## Mixed-Effects Model (k = 37; tau^2 estimator: REML)
##
## tau^2 (estimated amount of residual heterogeneity):     0.0412 (SE = 0.0231)
## tau (square root of estimated tau^2 value):             0.2029
```

```
## I^2 (residual heterogeneity / unaccounted variability): 45.44%
## H^2 (unaccounted variability / sampling variability):   1.83
## R^2 (amount of heterogeneity accounted for):            7.87%
##
## Test for Residual Heterogeneity:
## QE(df = 35) = 67.9680, p-val = 0.0007
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 5.9070, p-val = 0.0151
##
## Model Results:
##
##                estimate      se    zval    pval    ci.lb   ci.ub
## intrcpt          0.0776  0.0796  0.9756  0.3293  -0.0783  0.2336
## g1_hrsperweek    0.0836  0.0344  2.4304  0.0151   0.0162  0.1510  *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Covariate 2: g1txdays
rma_suoa_2<- rma(es, se^2, mod= ~ g1txdays, data=data_agregated)
```

```
## Warning in rma(es, se^2, mod = ~g1txdays, data = data_agregated): Studies with
## NAs omitted from model fitting.
```

```
rma_suoa_2
```

```
##
## Mixed-Effects Model (k = 45; tau^2 estimator: REML)
##
## tau^2 (estimated amount of residual heterogeneity):     0.0388 (SE = 0.0186)
## tau (square root of estimated tau^2 value):             0.1969
## I^2 (residual heterogeneity / unaccounted variability): 48.10%
## H^2 (unaccounted variability / sampling variability):   1.93
## R^2 (amount of heterogeneity accounted for):            0.00%
##
## Test for Residual Heterogeneity:
## QE(df = 43) = 87.7653, p-val < .0001
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 0.0032, p-val = 0.9551
##
## Model Results:
##
##           estimate      se     zval    pval    ci.lb   ci.ub
## intrcpt     0.1680  0.0834   2.0136  0.0441   0.0045  0.3316  *
## g1txdays   -0.0000  0.0007  -0.0563  0.9551  -0.0014  0.0013
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Using diff g1 and g2
#Covariate 1: g1hrsperweek
rma_suoa_diff1<- rma(es, se^2, mod= ~ hrsperweek, data=data_agregated)
```

```
## Warning in rma(es, se^2, mod = ~hrsperweek, data = data_agregated): Studies with
```

```
## NAs omitted from model fitting.
```

```
rma_suoa_diff1
```

```
##
## Mixed-Effects Model (k = 23; tau^2 estimator: REML)
##
## tau^2 (estimated amount of residual heterogeneity):     0.0652 (SE = 0.0385)
## tau (square root of estimated tau^2 value):             0.2553
## I^2 (residual heterogeneity / unaccounted variability): 56.03%
## H^2 (unaccounted variability / sampling variability):   2.27
## R^2 (amount of heterogeneity accounted for):            2.25%
##
## Test for Residual Heterogeneity:
## QE(df = 21) = 49.8619, p-val = 0.0004
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 1.7910, p-val = 0.1808
##
## Model Results:
##
##             estimate      se    zval    pval    ci.lb   ci.ub
## intrcpt       0.1552  0.0788  1.9702  0.0488   0.0008  0.3096  *
## hrsperweek    0.1914  0.1430  1.3383  0.1808  -0.0889  0.4718
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Covariate 2: g1txdays
rma_suoa_diff2<- rma(es, se^2, mod= ~ txdays, data=data_agregated)
```

```
## Warning in rma(es, se^2, mod = ~txdays, data = data_agregated): Studies with NAs
## omitted from model fitting.
```

```
rma_suoa_diff2
```

```
##
## Mixed-Effects Model (k = 27; tau^2 estimator: REML)
##
## tau^2 (estimated amount of residual heterogeneity):     0.0553 (SE = 0.0316)
## tau (square root of estimated tau^2 value):             0.2351
## I^2 (residual heterogeneity / unaccounted variability): 52.58%
## H^2 (unaccounted variability / sampling variability):   2.11
## R^2 (amount of heterogeneity accounted for):            0.00%
##
## Test for Residual Heterogeneity:
## QE(df = 25) = 55.0533, p-val = 0.0005
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 0.1628, p-val = 0.6866
##
## Model Results:
##
##          estimate      se    zval    pval    ci.lb   ci.ub
## intrcpt    0.1511  0.0660  2.2887  0.0221   0.0217  0.2805  *
## txdays     0.0064  0.0157  0.4034  0.6866  -0.0245  0.0372
```

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

Previous Analyses

Complete case analysis - Dependent ES

While effect sizes and sampling variances are not missing for this dataset, there are a number of moderator (covariates) variables that are. A total of 328 ES available in the data.

```
data_adt_cca<- data_adt[c("studyid", "es_g","se_g","g1hrsperweek","g1txdays")]

##delete NA
data_adt_na<- na.omit(data_adt_cca)

#Meta-regression
#random-effects model

#Using rma.mv uncentered group-mean
rma_mv_cca<- rma.mv(es_g, se_g^2, mods= ~ 1 + g1hrsperweek + g1txdays,
                                  random= ~ 1|studyid,
                                  data= data_adt_na,
                                   method="REML")
rma_mv_cca
```

```
##
## Multivariate Meta-Analysis Model (k = 247; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed   factor
## sigma^2    0.0825  0.2872     37     no  studyid
##
## Test for Residual Heterogeneity:
## QE(df = 244) = 435.8172, p-val < .0001
##
## Test of Moderators (coefficients 2:3):
## QM(df = 2) = 4.2647, p-val = 0.1186
##
## Model Results:
##
##               estimate      se     zval    pval    ci.lb   ci.ub
## intrcpt         0.2034  0.1310   1.5528  0.1205  -0.0533  0.4602
## g1hrsperweek    0.0755  0.0383   1.9719  0.0486   0.0005  0.1506  *
## g1txdays       -0.0009  0.0011  -0.8341  0.4042  -0.0032  0.0013
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Using rma.mv group-mean  centered
g1hrsperweek.w<- group.center(data_adt_na$g1hrsperweek, grp=data_adt_na$studyid)

rma_mv_cca_2<- rma.mv(es_g, se_g^2, mods= ~ 1 + g1hrsperweek.w + g1txdays,
                                  random= ~ 1|studyid,
                                  data= data_adt_na,
```

```
                                    method="REML")
rma_mv_cca_2
```

```
##
## Multivariate Meta-Analysis Model (k = 247; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed   factor
## sigma^2    0.0889  0.2981     37     no  studyid
##
## Test for Residual Heterogeneity:
## QE(df = 244) = 447.6719, p-val < .0001
##
## Test of Moderators (coefficients 2:3):
## QM(df = 2) = 1.0216, p-val = 0.6000
##
## Model Results:
##
##                 estimate      se     zval    pval    ci.lb   ci.ub
## intrcpt           0.3050  0.1240   2.4601  0.0139   0.0620  0.5481  *
## g1hrsperweek.w    0.1273  0.1543   0.8248  0.4095  -0.1751  0.4297
## g1txdays         -0.0007  0.0012  -0.5841  0.5592  -0.0030  0.0016
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Only k=247 ES were included in the analysis.Thus, aproximetly 25% of the ES were excluded from the analysis. illustrating the loss of data that can occur when conducting a complete case analysis.

Shifting units of analysis - Dependent ES

```
#Covariate 1: g1hrsperweek
##delete NA
data_subset<- data_adt_cca[, 1:4]
data_adt_na<- na.omit(data_subset)

#Meta-regression
#random-effects model
#Using rma.mv
rma_shu_cov1<- rma.mv(es_g, se_g^2, mods= ~ 1 +  g1hrsperweek,
                                    random= ~ 1|studyid,
                                   data= data_adt_na,
                                   method="REML")
rma_shu_cov1
```

```
##
## Multivariate Meta-Analysis Model (k = 249; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed   factor
## sigma^2    0.0863  0.2937     38     no  studyid
##
```

```
## Test for Residual Heterogeneity:
## QE(df = 247) = 460.4483, p-val < .0001
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 8.1039, p-val = 0.0044
##
## Model Results:
##
##               estimate      se    zval    pval    ci.lb   ci.ub
## intrcpt         0.0847  0.0808  1.0478  0.2947  -0.0737  0.2431
## g1hrsperweek    0.0972  0.0341  2.8467  0.0044   0.0303  0.1641  **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Using rma.mv group-mean  centered
g1hrsperweek.w<- group.center(data_adt_na$g1hrsperweek, grp=data_adt_na$studyid)

rma_shu_cov1<- rma.mv(es_g, se_g^2, mods= ~ 1 +  g1hrsperweek.w,
                                  random= ~ 1|studyid,
                                 data= data_adt_na,
                                 method="REML")
rma_shu_cov1
```

```
##
## Multivariate Meta-Analysis Model (k = 249; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed   factor
## sigma^2    0.0986  0.3141     38     no  studyid
##
## Test for Residual Heterogeneity:
## QE(df = 247) = 467.1476, p-val < .0001
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 0.6805, p-val = 0.4094
##
## Model Results:
##
##                estimate      se    zval    pval    ci.lb   ci.ub
## intrcpt          0.2583  0.0570  4.5297  <.0001   0.1466  0.3701  ***
## g1hrsperweek.w   0.1273  0.1543  0.8249  0.4094  -0.1751  0.4297
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Covariate 2: g1txdays
##delete NA
data_subset<- data_adt_cca[,c(1:3, 5)]
data_adt_na<- na.omit(data_subset)

#Meta-regression
#random-effects model
#Using rma.mv
```

```r
rma_shu_cov2<- rma.mv(es_g, se_g^2, mods= ~ 1 +  g1txdays,
                                    random= ~ 1|studyid,
                                   data= data_adt_na,
                                   method="REML")
rma_shu_cov2
```

```
##
## Multivariate Meta-Analysis Model (k = 326; method: REML)
##
## Variance Components:
##
##             estim    sqrt  nlvls  fixed   factor
## sigma^2    0.0799  0.2828     45     no  studyid
##
## Test for Residual Heterogeneity:
## QE(df = 324) = 570.2498, p-val < .0001
##
## Test of Moderators (coefficient 2):
## QM(df = 1) = 0.0247, p-val = 0.8752
##
## Model Results:
##
##           estimate      se     zval    pval    ci.lb   ci.ub
## intrcpt     0.2081  0.0635   3.2771  0.0010   0.0836  0.3326  **
## g1txdays   -0.0001  0.0004  -0.1571  0.8752  -0.0009  0.0007
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```