

Analyses output for Exploring the Longitudinal Clustering of Lifestyle Behaviors, Social Determinants of Health, and Depression

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```
library(tidyverse)
library(tidylog)
library(psych)
library(mice)
library(micemd)
library(BGGM)
library(qgraph)
```

1 Between-person network model on imputed data

1.1 Estimate the network model

```
midus_mids_between <- read_rds("midus_mids_between.rds")

fit_between <- bggm_missing(midus_mids_between,
                             type = "mixed", cores = 3)
```

1.2 View network model summary

```
summary(fit_between)
```

```
## BGGM: Bayesian Gaussian Graphical Models
## ---
## Type: mixed
## Analytic: FALSE
## Formula:
## Posterior Samples: 30050
## Observations (n):
## Nodes (p): 9
## Relations: 36
## ---
## Call:
## estimate(Y = subset(Y, .imp == x)[, -1], type = "mixed", iter = iter,
##       cores = 3)
## ---
## Estimates:
```

	Relation	Post.mean	Post.sd	Cred.lb	Cred.ub
##	dep_bin_mean--exercise_mean	0.064	0.012	0.044	0.089
##	dep_bin_mean--neigh_mean	-0.027	0.008	-0.042	-0.011
##	exercise_mean--neigh_mean	0.142	0.008	0.126	0.155
##	dep_bin_mean--smoke_mean	0.634	0.019	0.611	0.644
##	exercise_mean--smoke_mean	-0.028	0.010	-0.045	-0.005
##	neigh_mean--smoke_mean	0.087	0.008	0.073	0.103
##	dep_bin_mean--sleep_mean	0.255	0.010	0.239	0.271
##	exercise_mean--sleep_mean	-0.092	0.008	-0.107	-0.077
##	neigh_mean--sleep_mean	-0.018	0.007	-0.036	-0.008
##	smoke_mean--sleep_mean	-0.025	0.008	-0.044	-0.013
##	dep_bin_mean--income_mean	0.052	0.011	0.028	0.071
##	exercise_mean--income_mean	0.058	0.009	0.051	0.086
##	neigh_mean--income_mean	-0.043	0.008	-0.059	-0.028
##	smoke_mean--income_mean	-0.060	0.010	-0.077	-0.038
##	sleep_mean--income_mean	-0.073	0.008	-0.088	-0.056
##	dep_bin_mean--age_z	0.032	0.009	0.013	0.047
##	exercise_mean--age_z	-0.348	0.011	-0.357	-0.327
##	neigh_mean--age_z	0.223	0.009	0.207	0.236
##	smoke_mean--age_z	-0.058	0.009	-0.075	-0.042
##	sleep_mean--age_z	0.003	0.008	-0.010	0.021
##	income_mean--age_z	-0.207	0.009	-0.221	-0.189
##	dep_bin_mean--race	0.071	0.018	0.034	0.103
##	exercise_mean--race	-0.157	0.014	-0.175	-0.120
##	neigh_mean--race	0.094	0.013	0.063	0.114
##	smoke_mean--race	-0.030	0.016	-0.069	-0.005
##	sleep_mean--race	-0.124	0.014	-0.148	-0.096
##	income_mean--race	-0.195	0.015	-0.219	-0.164
##	age_z--race	-0.248	0.014	-0.268	-0.217
##	dep_bin_mean--female	0.126	0.039	0.093	0.235
##	exercise_mean--female	-0.209	0.011	-0.225	-0.185
##	neigh_mean--female	0.010	0.010	-0.012	0.027
##	smoke_mean--female	-0.045	0.024	-0.066	0.022
##	sleep_mean--female	0.071	0.010	0.053	0.093
##	income_mean--female	-0.180	0.014	-0.197	-0.149

```
##          age_z--female  -0.083  0.014  -0.101  -0.054
##          race--female  -0.007  0.020  -0.032  0.037
## ---
```

1.3 View partial correlation matrix

```
pcor_mat(fit_between)
```

```
##           dep_bin_mean exercise_mean neigh_mean smoke_mean sleep_mean
## dep_bin_mean      0.000      0.064     -0.027      0.634      0.255
## exercise_mean     0.064      0.000      0.142     -0.028     -0.092
## neigh_mean       -0.027      0.142      0.000      0.087     -0.018
## smoke_mean        0.634     -0.028      0.087      0.000     -0.025
## sleep_mean        0.255     -0.092     -0.018     -0.025      0.000
## income_mean       0.052      0.058     -0.043     -0.060     -0.073
## age_z             0.032     -0.348      0.223     -0.058      0.003
## race              0.071     -0.157      0.094     -0.030     -0.124
## female            0.126     -0.209      0.010     -0.045      0.071
##           income_mean age_z   race female
## dep_bin_mean      0.052 0.032 0.071 0.126
## exercise_mean     0.058 -0.348 -0.157 -0.209
## neigh_mean       -0.043 0.223 0.094 0.010
## smoke_mean       -0.060 -0.058 -0.030 -0.045
## sleep_mean       -0.073 0.003 -0.124 0.071
## income_mean       0.000 -0.207 -0.195 -0.180
## age_z            -0.207 0.000 -0.248 -0.083
## race             -0.195 -0.248 0.000 -0.007
## female          -0.180 -0.083 -0.007 0.000
```

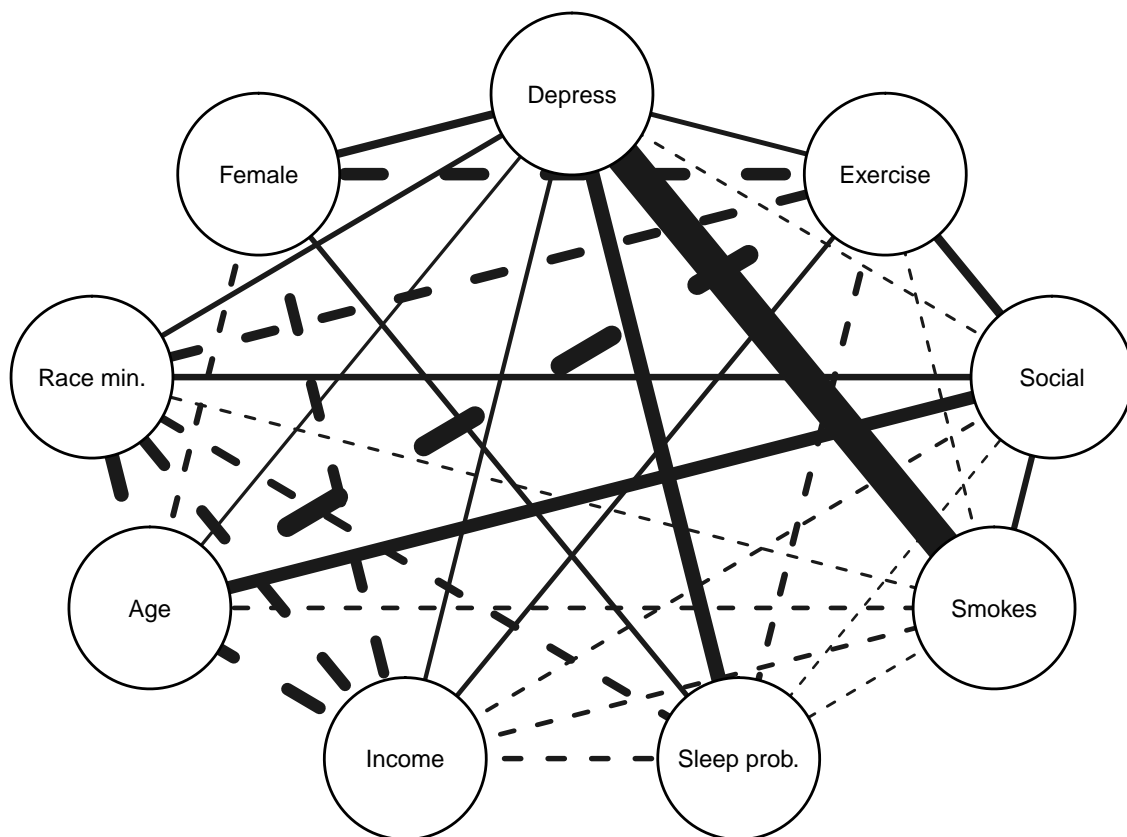
1.4 View network model plots

```
selected_between <- BGGM::select(fit_between)
between_mat <- selected_between$pcor_adj

between_namesr <- c("Depress", "Exercise", "Social",
                   "Smokes", "Sleep prob.", "Income", "Age",
                   "Race min.", "Female")
between_namesc <- c("Depress", "Exercise", "Social",
                   "Smokes", "Sleep prob.", "Income", "Age",
                   "Race min.", "Female")

dimnames(between_mat) <- list(between_namesr, between_namesc)

qgraph(between_mat, layout = 'circle', labels = colnames(between_mat),
       theme = 'gray',
       fade = FALSE,
       node.width = 1.75,
       border.width = 1.75,
       label.scale.equal = TRUE,
       edge.width = 1.5)
```



1.5 Calculate bridge strength

```
#Function for calculating strength centrality  
bridgestrength <- function(x, ...){networktools::bridge(x, ...)}`Bridge Strength`}
```

```
strength_between <- roll_your_own(fit_between,  
                                FUN = bridgestrength,  
                                select = TRUE,  
                                communities = between_namesr)
```

1.6 Plot bridge strength

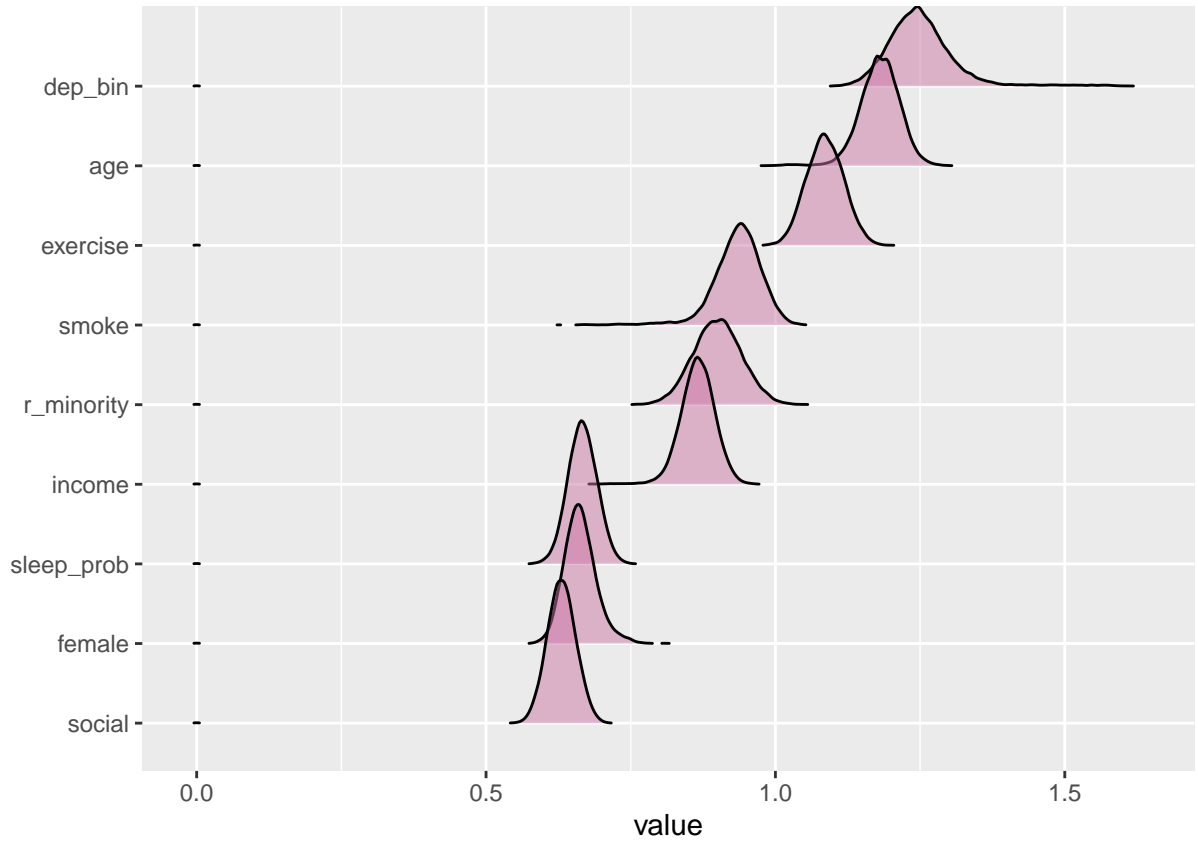
```
#change the names of the results to match the input  
dimnames(strength_between$results) <- list(c("dep_bin", "exercise", "social",  
                                             "smoke", "sleep_prob", "income", "age",  
                                             "r_minority", "female"), NULL)
```

```
# print  
strength_between
```

```
## BGGM: Bayesian Gaussian Graphical Models  
## ---  
## Network Stats: Roll Your Own  
## Posterior Samples: 30050  
## ---  
## Estimates:  
##  
## Node Post.mean Post.sd Cred.lb Cred.ub  
## 1 1.251 0.067 1.157 1.399  
## 2 1.085 0.040 1.025 1.149  
## 3 0.630 0.028 0.583 0.678  
## 4 0.934 0.047 0.838 1.005  
## 5 0.666 0.029 0.617 0.716  
## 6 0.865 0.036 0.805 0.921  
## 7 1.180 0.043 1.110 1.243  
## 8 0.900 0.046 0.818 0.983  
## 9 0.663 0.031 0.613 0.726  
## ---
```

```
#plot  
plot(strength_between)
```

```
## Picking joint bandwidth of 0.00377
```



2 Within-person network model on imputed data

2.1 Estimate the network model

```
midus_mids_within <- read_rds("midus_mids_within.rds")

fit_within <- bggm_missing(midus_mids_within,
                           type = "mixed", cores = 3)
```


2.2 View network model summary

```
summary(fit_within)
```

```
## BGGM: Bayesian Gaussian Graphical Models
## ---
## Type: mixed
## Analytic: FALSE
## Formula:
## Posterior Samples: 30050
## Observations (n):
## Nodes (p): 7
## Relations: 21
## ---
## Call:
## estimate(Y = subset(Y, .imp == x)[, -1], type = "mixed", iter = iter,
##       cores = 3)
## ---
## Estimates:
##           Relation Post.mean Post.sd Cred.lb Cred.ub
## dep_bin_c--exercise_c    0.018  0.009   0.001  0.035
##   dep_bin_c--neigh_c   -0.013  0.008  -0.034 -0.002
##   exercise_c--neigh_c    0.081  0.010   0.052  0.092
##   dep_bin_c--sleep_c    0.095  0.009   0.086  0.118
##   exercise_c--sleep_c  -0.027  0.009  -0.044 -0.010
##   neigh_c--sleep_c     -0.040  0.011  -0.056 -0.014
##   dep_bin_c--smoke_c    0.541  0.014   0.523  0.551
##   exercise_c--smoke_c  -0.016  0.010  -0.039 -0.002
##   neigh_c--smoke_c     0.036  0.008   0.028  0.061
##   sleep_c--smoke_c    -0.059  0.008  -0.076 -0.047
##   dep_bin_c--income_c  -0.017  0.009  -0.035  0.000
##   exercise_c--income_c  0.054  0.010   0.032  0.070
##   neigh_c--income_c   -0.034  0.012  -0.038  0.012
##   sleep_c--income_c   -0.030  0.009  -0.061 -0.025
##   smoke_c--income_c   -0.032  0.009  -0.049 -0.015
##   dep_bin_c--wave     0.231  0.009   0.220  0.248
##   exercise_c--wave     0.001  0.008  -0.012  0.017
##   neigh_c--wave        0.018  0.010  -0.007  0.032
##   sleep_c--wave        0.193  0.010   0.163  0.200
##   smoke_c--wave        0.136  0.008   0.119  0.148
##   income_c--wave       0.072  0.009   0.058  0.093
## ---
```

2.3 View partial correlation matrix

```
pcor_mat(fit_within)
```

```
##           dep_bin_c exercise_c neigh_c sleep_c smoke_c income_c wave
## dep_bin_c      0.000      0.018 -0.013  0.095  0.541  -0.017 0.231
## exercise_c      0.018      0.000  0.081 -0.027 -0.016   0.054 0.001
## neigh_c        -0.013      0.081  0.000 -0.040  0.036  -0.034 0.018
## sleep_c         0.095     -0.027 -0.040  0.000 -0.059  -0.030 0.193
## smoke_c         0.541     -0.016  0.036 -0.059  0.000  -0.032 0.136
## income_c       -0.017      0.054 -0.034 -0.030 -0.032   0.000 0.072
## wave           0.231      0.001  0.018  0.193  0.136   0.072 0.000
```

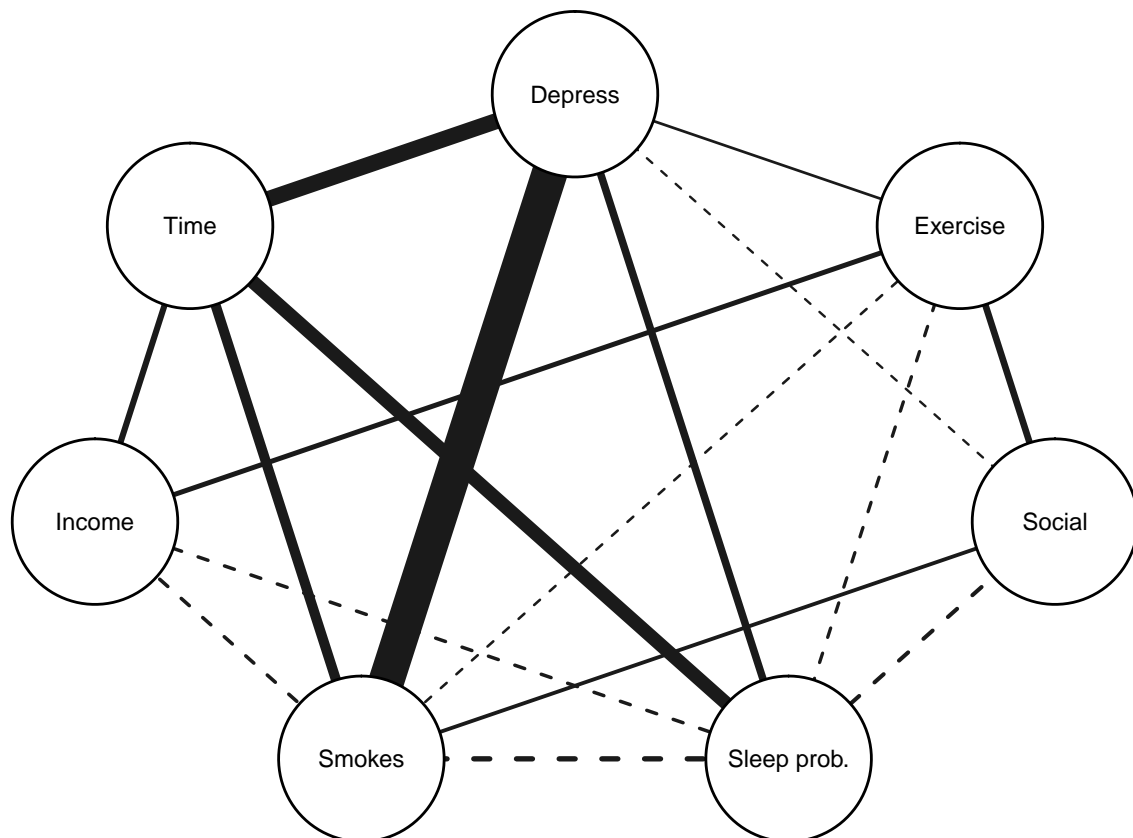
2.4 View network model plots

```
selected_within <- BGGM::select(fit_within)
within_mat <- selected_within$pcor_adj

within_namesr <- c("Depress", "Exercise", "Social", "Sleep prob.",
                  "Smokes", "Income", "Time")
within_namesc <- c("Depress", "Exercise", "Social", "Sleep prob.",
                  "Smokes", "Income", "Time")

dimnames(within_mat) <- list(within_namesr, within_namesc)

qgraph(within_mat, layout = 'circle', labels = colnames(within_mat),
        theme = 'gray',
        fade = FALSE,
        node.width = 1.75,
        border.width = 1.75,
        label.scale.equal = TRUE,
        edge.width = 1.5)
```



2.5 Calculate bridge strength

```
strength_within <- roll_your_own(fit_within,  
                                FUN = bridgestrength,  
                                select = TRUE,  
                                communities = within_namesr)
```

2.6 Plot bridge strength

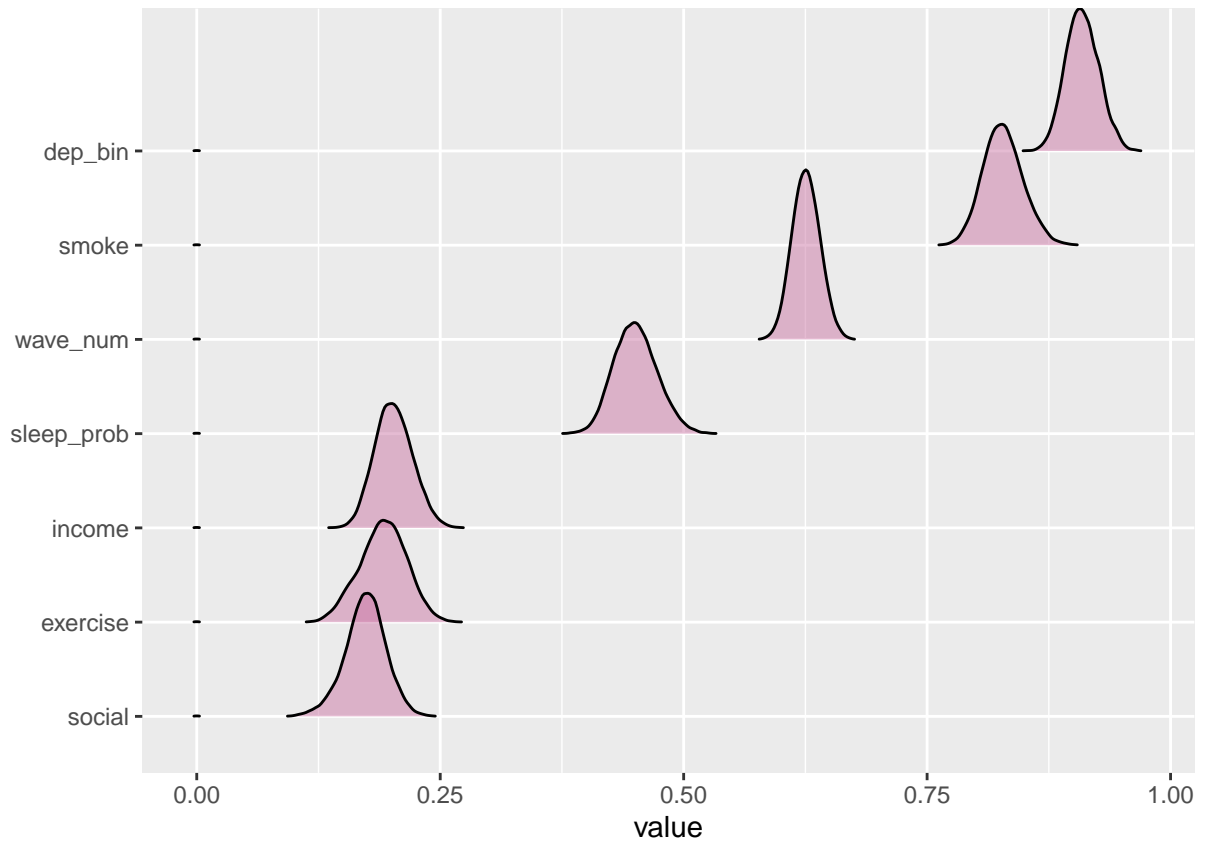
```
#change the names of the results to match the input  
dimnames(strength_within$results) <- list(c("dep_bin", "exercise", "social", "sleep_prob",  
                                             "smoke", "income", "wave_num"), NULL)
```

```
# print  
strength_within
```

```
## BGGM: Bayesian Gaussian Graphical Models  
## ---  
## Network Stats: Roll Your Own  
## Posterior Samples: 30050  
## ---  
## Estimates:  
##  
## Node Post.mean Post.sd Cred.lb Cred.ub  
## 1 0.909 0.026 0.878 0.944  
## 2 0.191 0.024 0.143 0.237  
## 3 0.173 0.021 0.128 0.213  
## 4 0.451 0.024 0.410 0.496  
## 5 0.828 0.027 0.790 0.870  
## 6 0.202 0.020 0.167 0.242  
## 7 0.625 0.020 0.598 0.654  
## ---
```

```
#plot  
plot(strength_within)
```

```
## Picking joint bandwidth of 0.00227
```



3 Between-person network on completer data

3.1 Estimate the network model

```
completers <- read_rds('midus_long_completers.rds')  
  
between_completers <- estimate(completers,  
                               type = "mixed", cores = 3)
```

3.2 View network model summary

```
summary(fit_between_completers)
```

```
## BGGM: Bayesian Gaussian Graphical Models
## ---
## Type: mixed
## Analytic: FALSE
## Formula:
## Posterior Samples: 5000
## Observations (n):
## Nodes (p): 9
## Relations: 36
## ---
## Call:
## estimate(Y = between_completers, type = "mixed", analytic = FALSE,
##         cores = 3)
## ---
## Estimates:
##           Relation Post.mean Post.sd Cred.lb Cred.ub
## dep_bin_mean--exercise_mean    0.059  0.025  0.008  0.107
##   dep_bin_mean--neigh_mean     0.011  0.023 -0.036  0.057
##   exercise_mean--neigh_mean    0.190  0.023  0.145  0.234
##   dep_bin_mean--smoke_mean     0.794  0.016  0.756  0.820
##   exercise_mean--smoke_mean   -0.048  0.025 -0.098  0.001
##     neigh_mean--smoke_mean     0.034  0.023 -0.012  0.081
##   dep_bin_mean--sleep_mean     0.203  0.024  0.155  0.250
##   exercise_mean--sleep_mean   -0.045  0.024 -0.091  0.003
##     neigh_mean--sleep_mean    -0.078  0.023 -0.124 -0.032
##     smoke_mean--sleep_mean    -0.089  0.024 -0.136 -0.041
##   dep_bin_mean--income_mean    0.032  0.026 -0.020  0.081
##   exercise_mean--income_mean   0.103  0.025  0.053  0.151
##     neigh_mean--income_mean   -0.008  0.024 -0.055  0.040
##     smoke_mean--income_mean  -0.061  0.025 -0.110 -0.011
##     sleep_mean--income_mean  -0.083  0.025 -0.132 -0.034
##     dep_bin_mean--sex         0.150  0.042  0.078  0.242
##     exercise_mean--sex       -0.234  0.029 -0.290 -0.178
##       neigh_mean--sex       -0.018  0.029 -0.075  0.038
##       smoke_mean--sex       -0.025  0.037 -0.092  0.053
##       sleep_mean--sex       0.136  0.030  0.078  0.194
##       income_mean--sex     -0.157  0.031 -0.218 -0.095
##     dep_bin_mean--age_z      0.006  0.024 -0.042  0.052
##     exercise_mean--age_z    -0.286  0.022 -0.329 -0.242
##       neigh_mean--age_z     0.209  0.023  0.165  0.253
##       smoke_mean--age_z    -0.016  0.024 -0.063  0.030
##       sleep_mean--age_z     0.043  0.024 -0.003  0.090
##       income_mean--age_z   -0.167  0.024 -0.212 -0.121
##         sex--age_z        -0.153  0.030 -0.211 -0.093
##     dep_bin_mean--race     -0.035  0.070 -0.179  0.095
##     exercise_mean--race    -0.090  0.049 -0.186  0.006
##       neigh_mean--race     0.040  0.048 -0.054  0.132
##       smoke_mean--race    -0.085  0.065 -0.212  0.037
##       sleep_mean--race    -0.099  0.051 -0.194  0.001
##       income_mean--race   -0.162  0.050 -0.257 -0.061
```

```
##          sex--race    0.055  0.063 -0.067  0.179
##          age_z--race -0.063  0.050 -0.161  0.035
## ---
```


3.3 View partial correlation matrix

```
pcor_mat(fit_between_completers)
```

```
##           dep_bin_mean exercise_mean neigh_mean smoke_mean sleep_mean
## dep_bin_mean      0.000      0.059      0.011      0.794      0.203
## exercise_mean     0.059      0.000      0.190     -0.048     -0.045
## neigh_mean        0.011      0.190      0.000      0.034     -0.078
## smoke_mean        0.794     -0.048      0.034      0.000     -0.089
## sleep_mean        0.203     -0.045     -0.078     -0.089      0.000
## income_mean       0.032      0.103     -0.008     -0.061     -0.083
## sex               0.150     -0.234     -0.018     -0.025      0.136
## age_z             0.006     -0.286      0.209     -0.016      0.043
## race             -0.035     -0.090      0.040     -0.085     -0.099
##           income_mean  sex  age_z  race
## dep_bin_mean      0.032  0.150  0.006 -0.035
## exercise_mean     0.103 -0.234 -0.286 -0.090
## neigh_mean       -0.008 -0.018  0.209  0.040
## smoke_mean       -0.061 -0.025 -0.016 -0.085
## sleep_mean       -0.083  0.136  0.043 -0.099
## income_mean      0.000 -0.157 -0.167 -0.162
## sex              -0.157  0.000 -0.153  0.055
## age_z            -0.167 -0.153  0.000 -0.063
## race             -0.162  0.055 -0.063  0.000
```

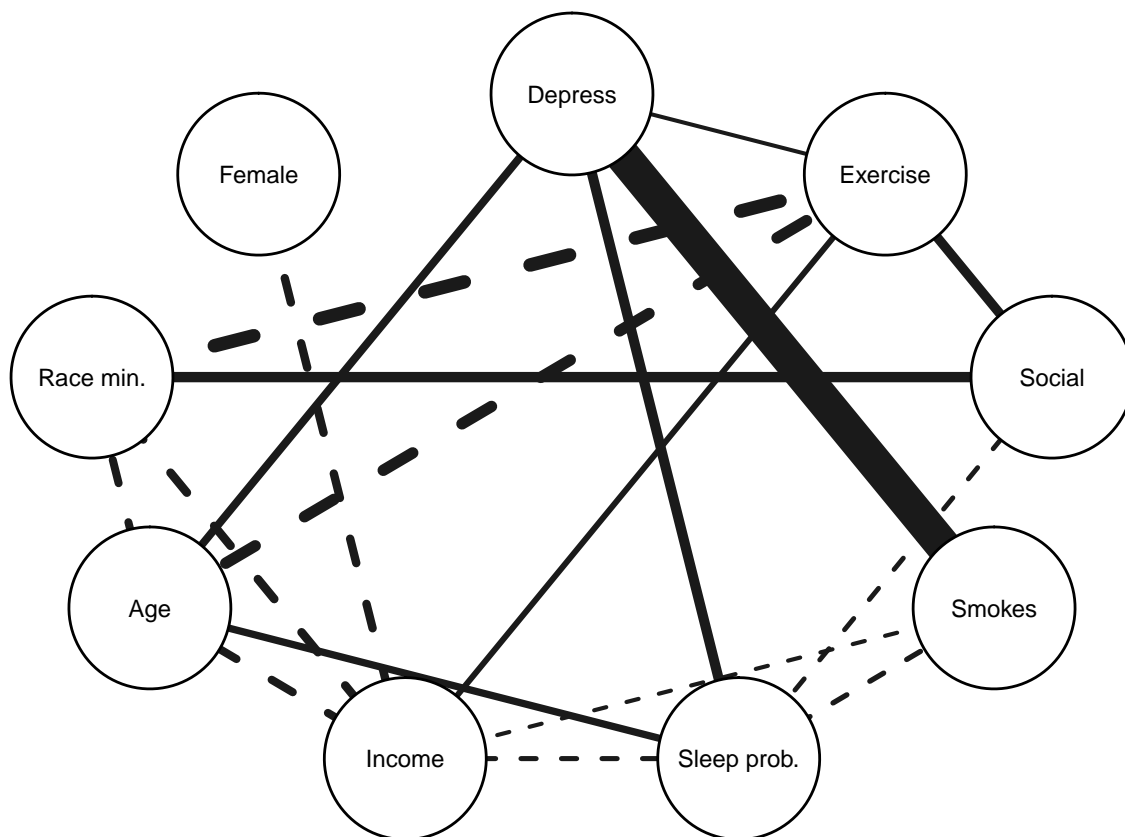
3.4 View network model plots

```
selected_between_completers <- BGGM::select(fit_between_completers)
between_mat_completers <- selected_between_completers$pcor_adj

between_namesr <- c("Depress", "Exercise", "Social",
                   "Smokes", "Sleep prob.", "Income", "Age",
                   "Race min.", "Female")
between_namesc <- c("Depress", "Exercise", "Social",
                   "Smokes", "Sleep prob.", "Income", "Age",
                   "Race min.", "Female")

dimnames(between_mat_completers) <- list(between_namesr, between_namesc)

qgraph(between_mat_completers, layout = 'circle', labels = colnames(between_mat_completers),
       theme = 'gray',
       fade = FALSE,
       node.width = 1.75,
       border.width = 1.75,
       label.scale.equal = TRUE,
       edge.width = 1.5)
```



3.5 Calculate bridge strength

```
bridgestrength_between_completers <- roll_your_own(fit_between_completers,  
  FUN = bridgestrength,  
  select = TRUE,  
  communities = between_namesr)
```

3.6 Plot bridge strength

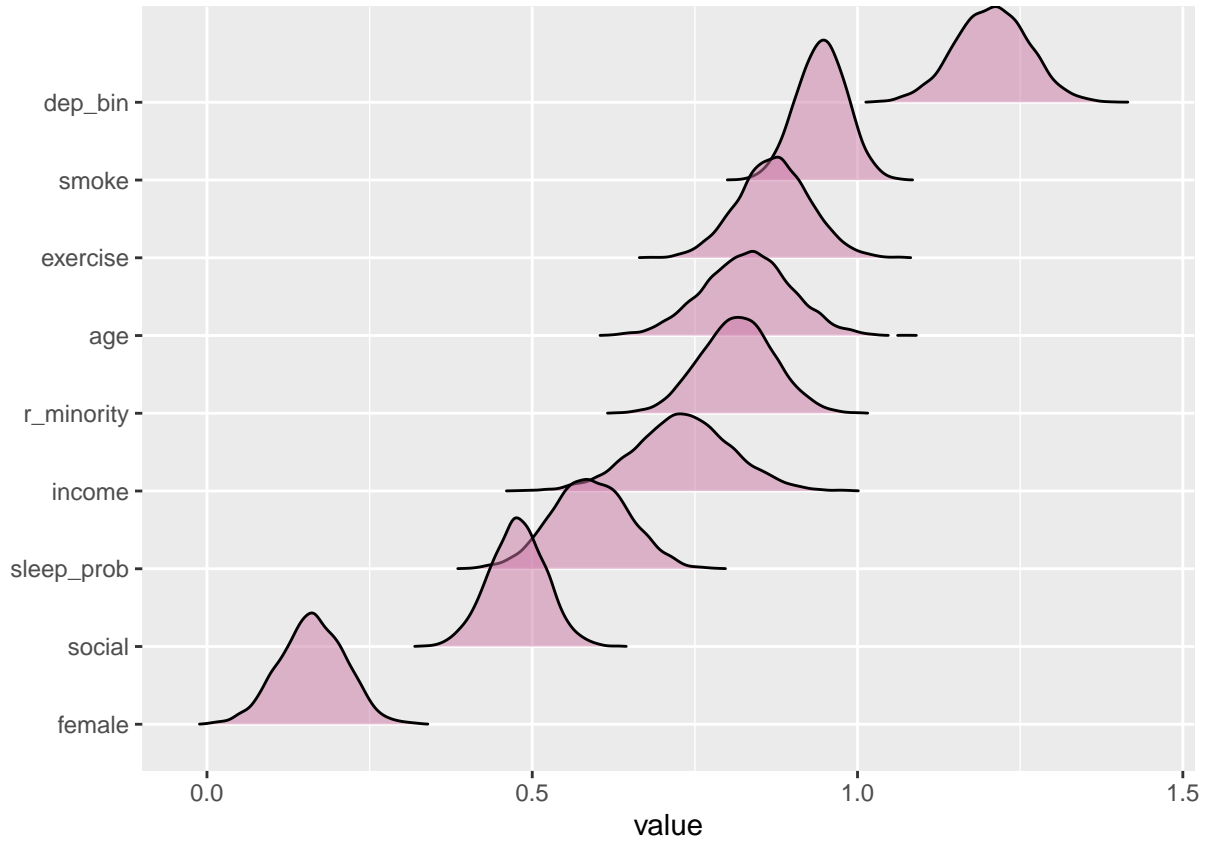
```
#change the names of the results to match the input  
dimnames(strength_between_completers$results) <- list(c("dep_bin", "exercise", "social",  
  "smoke", "sleep_prob", "income", "age",  
  "r_minority", "female"), NULL)
```

```
# print  
strength_between_completers
```

```
## BGGM: Bayesian Gaussian Graphical Models  
## ---  
## Network Stats: Roll Your Own  
## Posterior Samples: 5000  
## ---  
## Estimates:  
##  
## Node Post.mean Post.sd Cred.lb Cred.ub  
## 1 1.207 0.056 1.096 1.315  
## 2 0.871 0.055 0.762 0.981  
## 3 0.477 0.043 0.391 0.562  
## 4 0.945 0.038 0.869 1.019  
## 5 0.589 0.059 0.474 0.707  
## 6 0.733 0.075 0.583 0.880  
## 7 0.831 0.067 0.700 0.960  
## 8 0.815 0.056 0.706 0.925  
## 9 0.162 0.050 0.061 0.257  
## ---
```

```
#plot  
plot(strength_between_completers)
```

```
## Picking joint bandwidth of 0.00903
```



4 Within-person network model on completer data

4.1 Estimate the network model

```
completers <- read_rds("midus_long_completers.rds")  
  
fit_within_completers <- estimate(completers,  
                                  type = "mixed", cores = 3)
```

4.2 View network model summary

```
summary(fit_within_completers)
```

```
## BGGM: Bayesian Gaussian Graphical Models
## ---
## Type: mixed
## Analytic: FALSE
## Formula:
## Posterior Samples: 5000
## Observations (n):
## Nodes (p): 7
## Relations: 21
## ---
## Call:
## estimate(Y = within_completers, type = "mixed", analytic = FALSE,
##         cores = 3)
## ---
## Estimates:
##           Relation Post.mean Post.sd Cred.lb Cred.ub
## dep_bin_c--exercise_c    0.048  0.013   0.023  0.074
##   dep_bin_c--neigh_c     0.002  0.013  -0.024  0.028
##   exercise_c--neigh_c    0.037  0.013   0.011  0.062
##   dep_bin_c--sleep_c     0.039  0.013   0.013  0.065
##   exercise_c--sleep_c   -0.018  0.013  -0.044  0.008
##   neigh_c--sleep_c     -0.027  0.013  -0.053  0.000
##   dep_bin_c--smoke_c     0.579  0.009   0.562  0.596
##   exercise_c--smoke_c   -0.013  0.013  -0.039  0.013
##   neigh_c--smoke_c      0.023  0.013  -0.002  0.050
##   sleep_c--smoke_c     -0.075  0.013  -0.101 -0.049
##   dep_bin_c--income_c   -0.034  0.013  -0.059 -0.009
##   exercise_c--income_c   0.011  0.013  -0.015  0.037
##   neigh_c--income_c    -0.018  0.013  -0.044  0.008
##   sleep_c--income_c    -0.050  0.013  -0.075 -0.024
##   smoke_c--income_c    -0.026  0.013  -0.051  0.000
##   dep_bin_c--wave_num   0.168  0.013   0.142  0.193
##   exercise_c--wave_num  -0.071  0.013  -0.096 -0.045
##   neigh_c--wave_num     0.025  0.013  -0.001  0.050
##   sleep_c--wave_num     0.285  0.012   0.261  0.309
##   smoke_c--wave_num     0.236  0.013   0.212  0.260
##   income_c--wave_num    0.126  0.013   0.101  0.152
## ---
```

4.3 View partial correlation matrix

```
pcor_mat(fit_within_completers)
```

```
##           dep_bin_c exercise_c neigh_c sleep_c smoke_c income_c wave_num
## dep_bin_c    0.000    0.048  0.002  0.039  0.579  -0.034  0.168
## exercise_c   0.048    0.000  0.037 -0.018 -0.013  0.011 -0.071
## neigh_c      0.002    0.037  0.000 -0.027  0.023  -0.018  0.025
## sleep_c      0.039   -0.018 -0.027  0.000 -0.075  -0.050  0.285
## smoke_c      0.579   -0.013  0.023 -0.075  0.000  -0.026  0.236
## income_c    -0.034    0.011 -0.018 -0.050 -0.026  0.000  0.126
## wave_num     0.168   -0.071  0.025  0.285  0.236  0.126  0.000
```

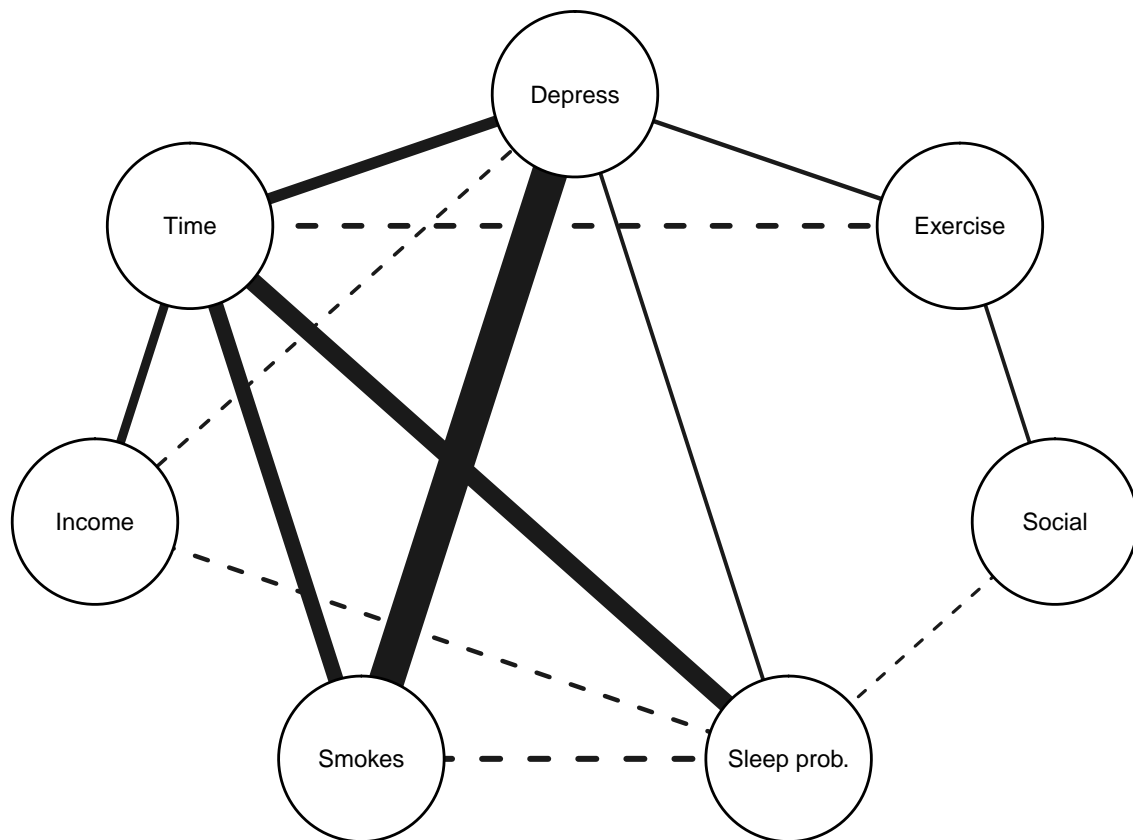
4.4 View network model plots

```
selected_within_completers <- BGGM::select(fit_within_completers)
within_mat <- selected_within_completers$pcor_adj

within_namesr <- c("Depress", "Exercise", "Social", "Sleep prob.",
                  "Smokes", "Income", "Time")
within_namesc <- c("Depress", "Exercise", "Social", "Sleep prob.",
                  "Smokes", "Income", "Time")

dimnames(within_mat) <- list(within_namesr, within_namesc)

qgraph(within_mat, layout = 'circle', labels = colnames(within_mat),
       theme = 'gray',
       fade = FALSE,
       node.width = 1.75,
       border.width = 1.75,
       label.scale.equal = TRUE,
       edge.width = 1.5)
```



4.5 Calculate bridge strength

```
bridgestrength_within <- roll_your_own(fit_within_completers,  
                                       FUN = bridgestrength,  
                                       select = TRUE,  
                                       communities = within_namesr)
```

4.6 Plot bridge strength

```
#change the names of the results to match the input  
dimnames(strength_within_completers$results) <- list(c("dep_bin", "exercise", "social", "sleep_prob",  
                                                       "smoke", "income", "wave_num"), NULL)
```

```
# print  
strength_within_completers
```

```
## BGGM: Bayesian Gaussian Graphical Models  
## ---  
## Network Stats: Roll Your Own  
## Posterior Samples: 5000  
## ---  
## Estimates:  
##  
## Node Post.mean Post.sd Cred.lb Cred.ub  
## 1 0.868 0.025 0.818 0.918  
## 2 0.156 0.024 0.109 0.202  
## 3 0.064 0.018 0.029 0.101  
## 4 0.475 0.032 0.413 0.540  
## 5 0.890 0.021 0.849 0.933  
## 6 0.210 0.025 0.159 0.259  
## 7 0.885 0.025 0.835 0.935  
## ---
```

```
#plot  
plot(strength_within_completers)
```

```
## Picking joint bandwidth of 0.00401
```

