ADA2: Class 27, ATUS data subset and model selection

Advanced Data Analysis 2, Stat 428/528, Spring 2023, Prof. Erik Erhardt, UNM

AUTHOR
Ryan Riner

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The **American Time Use Survey (ATUS)** measures the amount of time people spend doing various activities, such as paid work, childcare, volunteering, and socializing. We use my summarized version of the USA BLS.gov ATUS 2003-2021 Multi-Year Microdata Files.

1 Rubric

Complete everything below.

---

2 (1 p) Personalized analysis conditions

Set your personalized analysis conditions. This assigns to you an effectively random sample from the dataset, a stepwise selection strategy, and a model selection criterion.

Your path through this analysis will differ depending on your name and birth date.

1. Sample of data.
    - Choose a random number seed based on your first and last name initials and birth day of the month.

```
# example: EE and 14th becomes 050514, where each E = 05th letter of the alphabet
condition_1_seed <- 181818
```

2. Stepwise selection starting model.
    - If your birth day of the month is **01–10**, then your stepwise model selection will start with the **mean (empty) model**. Choose index `[1]` below.
    - If your birth day of the month is **11–20**, then your stepwise model selection will start with the **main effects model**. Choose index `[2]` below.
    - If your birth day of the month is **21–31**, then your stepwise model selection will start with the **two-way interaction model**. Choose index `[3]` below.

```
# example: 14th becomes "Main effects", that's the 2nd index
condition_2_init_model <- c("Mean", "Main effects", "Two-way interaction")[2]
```

3. Model selection criterion.

- If your birth month is **01–06**, then use **AIC** for model selection. Choose index `[1]` below.
- If your birth month is **07–12**, then use **BIC** for model selection. Choose index `[2]` below.

We will compare the results of all of the assignments, so please do your best with your given conditions. The point I hope will become clear is that the results are sensitive to the sample and the choices you make in analysis.

```
# example: December is 12th month, giving "BIC", that's the 2nd index
condition_3_criterion <- c("AIC", "BIC")[1]
```

4. Everyone will use $n = 500$ observations for analysis.
   - This is large enough to clearly identify patterns in the data but not overwhelmingly large to detect tiny effects.
   - Do not change this value.

```
n_analysis <- 500
```

3 Data

3.1 Read and format

These data have been prepared for you.

```
library(erikmisc)
```

```
── Attaching packages ──────────────────────────────────────── erikmisc 0.1.22 ──

✓ tibble 3.1.8     ✓ dplyr  1.1.0

── Conflicts ─────────────────────────────────────────── erikmisc_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()

erikmisc, solving common complex data analysis workflows
  by Dr. Erik Barry Erhardt <erik@StatAcumen.com>
```

```
library(tidyverse)
```

```
── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
```

```
✓ forcats   1.0.0     ✓ readr     2.1.4
✓ ggplot2   3.4.1     ✓ stringr   1.5.0
✓ lubridate 1.9.2     ✓ tidyr     1.3.0
✓ purrr     1.0.1
```

```
── Conflicts ─────────────────────────────────────── tidyverse_conflicts() ──
✖ dplyr::filter() masks stats::filter()
✖ dplyr::lag()    masks stats::lag()
ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts
to become errors
```

```
library(erikdata)   # ATUS data, install with devtools::install_github("erikerhardt/e
library(labelled)   # for variabel labels, use: var_label(dat_atus$TUCASEID)

set.seed(condition_1_seed)  # must run prior to dplyr::slice_sample() to draw the sam

dat_atus <-
  erikdata::dat_atus %>%
  dplyr::select(
    TUCASEID
  , t0101, TESEX, TEAGE, GTMETSTA, PEEDUCA, TRERNHLY, TEHRUSL1, TEHRUSL2, TRHHCHILD,
  )

# list of variables with their labels
labels_dat_atus %>%
  dplyr::filter(
    Var %in% names(dat_atus)
  )
```

```
# A tibble: 12 × 2
   Var         Label
   <chr>       <chr>
 1 TUCASEID    ATUS Case ID (14-digit identifier)
 2 TESEX       Edited: sex
 3 TEAGE       Edited: age
 4 GTMETSTA    Metropolitan status (2000 or 2010 definitions, see note)
 5 PEEDUCA     Edited: what is the highest level of school you have completed o…
 6 TRERNHLY    Hourly earnings (2 implied decimals)
 7 TRHHCHILD   Presence of household children < 18
 8 TRTALONE    Total time respondent spent alone (in minutes)
 9 TRTHHFAMILY Total time respondent spent with household family members (in mi…
10 TEHRUSL1    Edited: how many hours per week do you usually work at your main…
11 TEHRUSL2    Edited: how many hours per week do you usually work at your othe…
12 t0101       Sleeping
```

```
dat_atus <-
  dat_atus %>%
  dplyr::filter(
    TRERNHLY > 0    # only people who work and earn an hourly wage
  , t0101 > 0       # only people who went to sleep
  ) %>%
  dplyr::mutate(
    t0101 = t0101 / 60  # convert minutes to hours
  , PEEDUCA_num =
      case_when(
        PEEDUCA == "Less than 1st grade"                                ~  0   #  1
      , PEEDUCA == "1st, 2nd, 3rd, or 4th grade"                        ~  2.5 #  2
      , PEEDUCA == "5th or 6th grade"                                   ~  5.5 #  3
      , PEEDUCA == "7th or 8th grade"                                   ~  7.5 #  4
      , PEEDUCA == "9th grade"                                          ~  9   #  5
      , PEEDUCA == "10th grade"                                         ~ 10   #  6
      , PEEDUCA == "11th grade"                                         ~ 11   #  7
      , PEEDUCA == "12th grade - no diploma"                            ~ 12   #  8
      , PEEDUCA == "High school graduate - diploma or equivalent (GED)" ~ 12   #  9
      , PEEDUCA == "Some college but no degree"                         ~ 13   # 10
      , PEEDUCA == "Associate degree - occupational/vocational"         ~ 14   # 11
      , PEEDUCA == "Associate degree - academic program"                ~ 14   # 12
      , PEEDUCA == "Bachelor's degree (BA, AB, BS, etc.)"               ~ 16   # 13
      , PEEDUCA == "Master's degree (MA, MS, MEng, MEd, MSW, etc.)"     ~ 18   # 14
      , PEEDUCA == "Professional school degree (MD, DDS, DVM, etc.)"    ~ 21   # 15
      , PEEDUCA == "Doctoral degree (PhD, EdD, etc.)"                   ~ 21   # 16
      , TRUE ~ NA %>% as.numeric()
      )
    # set the "Not identified" Metropolitan areas to NA
  , GTMETSTA =
      GTMETSTA %>%
      factor(
        levels =
          # keep the levels that are not "Not identified"
          stringr::str_subset(
            string  = levels(dat_atus$GTMETSTA)
          , pattern = "Not identified"
          , negate  = TRUE
          )
      )
    # hours worked at all jobs
  , TEHRUSL_all = TEHRUSL1 + TEHRUSL2
  ) %>%
  dplyr::select(
    -PEEDUCA
```

```
  , -TEHRUSL1
  , -TEHRUSL2
  ) %>%
  # drop rows with any missing values
  tidyr::drop_na() %>%
  # select your sample of rows for analysis
  dplyr::slice_sample(
    n = n_analysis
  )

# label new variables
labelled::var_label(dat_atus[[ "PEEDUCA_num" ]]) <-
  labelled::var_label(dat_atus[[ "PEEDUCA" ]])
# relabel variables that were modified in a way that removes the label attribute
labelled::var_label(dat_atus[[ "GTMETSTA" ]]) <-
  labels_dat_atus %>% filter(Var == "GTMETSTA") %>% pull(Label)
labelled::var_label(dat_atus[[ "TEHRUSL_all" ]]) <-
  labels_dat_atus %>% filter(Var == "TEHRUSL1") %>% pull(Label)


# wrap all labels for plots
for (i_var in seq_len(ncol(dat_atus))) {
  labelled::var_label(dat_atus[, i_var]) <-
    labelled::var_label(dat_atus[, i_var]) %>%
    str_wrap(width = 30)
}
```

```
Warning in stri_split_lines(str): argument is not an atomic vector; coercing
```

```
str(dat_atus)
```

```
tibble [500 × 11] (S3: tbl_df/tbl/data.frame)
 $ TUCASEID   : num [1:500] 2.02e+13 2.02e+13 2.01e+13 2.01e+13 2.02e+13 ...
  ..- attr(*, "label")= chr "ATUS Case ID (14-digit\nidentifier)"
 $ t0101      : num [1:500] 9.85 11.33 7.25 7.75 9.75 ...
  ..- attr(*, "label")= chr "Sleeping"
 $ TESEX      : Factor w/ 2 levels "Male","Female": 2 2 1 2 2 1 2 1 1 2 ...
  ..- attr(*, "label")= chr "Edited: sex"
 $ TEAGE      : num [1:500] 31 50 41 41 38 60 34 31 42 17 ...
  ..- attr(*, "label")= chr "Edited: age"
 $ GTMETSTA   : Factor w/ 2 levels "Metropolitan",..: 1 1 1 1 1 1 1 1 1 2 ...
  ..- attr(*, "label")= chr "Metropolitan status (2000 or\n2010 definitions, see
note)"
 $ TRERNHLY   : num [1:500] 2000 1500 925 2050 950 ...
  ..- attr(*, "label")= chr "Hourly earnings (2 implied\ndecimals)"
```

```
 $ TRHHCHILD  : Factor w/ 2 levels "Yes","No": 2 1 2 2 1 2 2 2 2 1 ...
  ..- attr(*, "label")= chr "Presence of household children\n< 18"
 $ TRTALONE   : num [1:500] 477 0 495 970 90 435 300 35 523 320 ...
  ..- attr(*, "label")= chr "Total time respondent spent\nalone (in minutes)"
 $ TRTHHFAMILY: num [1:500] 222 730 0 0 720 300 0 0 0 380 ...
  ..- attr(*, "label")= chr "Total time respondent spent\nwith household family
members\n(in minutes)"
 $ PEEDUCA_num: num [1:500] 13 12 12 14 18 16 12 9 12 12 ...
  ..- attr(*, "label")= chr "NULL"
 $ TEHRUSL_all: num [1:500] 39 34 39 39 34 19 39 39 39 24 ...
  ..- attr(*, "label")= chr "Edited: how many hours per\nweek do you usually work
at\nyour main job?"
```

3.2 Data decisions start here

There are probably some unsustainably short or long numbers of hours slept. Let's filter to keep only people who slept at least 5 and at most 12 hours of sleep.

Add any other changes to this code for filtering, excluding outliers, or transforming variables.

```
## filter and mutate data here to satisfy model assumptions
dat_atus <-
  dat_atus %>%
  dplyr::filter(
    t0101 >= 5
  , t0101 <= 12
  ) %>%
  dplyr::mutate(
    id = 1:n()
  ) %>%
  dplyr::filter(
    id %notin% c(50,243,220)   # Can use this to exclude observations by ID number
  )

str(dat_atus)
```

```
tibble [438 × 12] (S3: tbl_df/tbl/data.frame)
 $ TUCASEID   : num [1:438] 2.02e+13 2.02e+13 2.01e+13 2.01e+13 2.02e+13 ...
  ..- attr(*, "label")= chr "ATUS Case ID (14-digit\nidentifier)"
 $ t0101      : num [1:438] 9.85 11.33 7.25 7.75 9.75 ...
  ..- attr(*, "label")= chr "Sleeping"
 $ TESEX      : Factor w/ 2 levels "Male","Female": 2 2 1 2 2 1 2 1 1 2 ...
  ..- attr(*, "label")= chr "Edited: sex"
 $ TEAGE      : num [1:438] 31 50 41 41 38 60 34 31 42 55 ...
```

```
  ..- attr(*, "label")= chr "Edited: age"
 $ GTMETSTA   : Factor w/ 2 levels "Metropolitan",..: 1 1 1 1 1 1 1 1 1 1 ...
  ..- attr(*, "label")= chr "Metropolitan status (2000 or\n2010 definitions, see
note)"
 $ TRERNHLY   : num [1:438] 2000 1500 925 2050 950 ...
  ..- attr(*, "label")= chr "Hourly earnings (2 implied\ndecimals)"
 $ TRHHCHILD  : Factor w/ 2 levels "Yes","No": 2 1 2 2 1 2 2 2 2 2 ...
  ..- attr(*, "label")= chr "Presence of household children\n< 18"
 $ TRTALONE   : num [1:438] 477 0 495 970 90 435 300 35 523 293 ...
  ..- attr(*, "label")= chr "Total time respondent spent\nalone (in minutes)"
 $ TRTHHFAMILY: num [1:438] 222 730 0 0 720 300 0 0 0 0 ...
  ..- attr(*, "label")= chr "Total time respondent spent\nwith household family
members\n(in minutes)"
 $ PEEDUCA_num: num [1:438] 13 12 12 14 18 16 12 9 12 14 ...
  ..- attr(*, "label")= chr "NULL"
 $ TEHRUSL_all: num [1:438] 39 34 39 39 34 19 39 39 39 39 ...
  ..- attr(*, "label")= chr "Edited: how many hours per\nweek do you usually work
at\nyour main job?"
 $ id         : int [1:438] 1 2 3 4 5 6 7 8 9 10 ...
```

3.3 Plot

Set `eval: false` to skip this plot once you're satisfied with the data choices you've made. **Please remember to set it back to** `true` so that this plot appears as part of your homework submission.

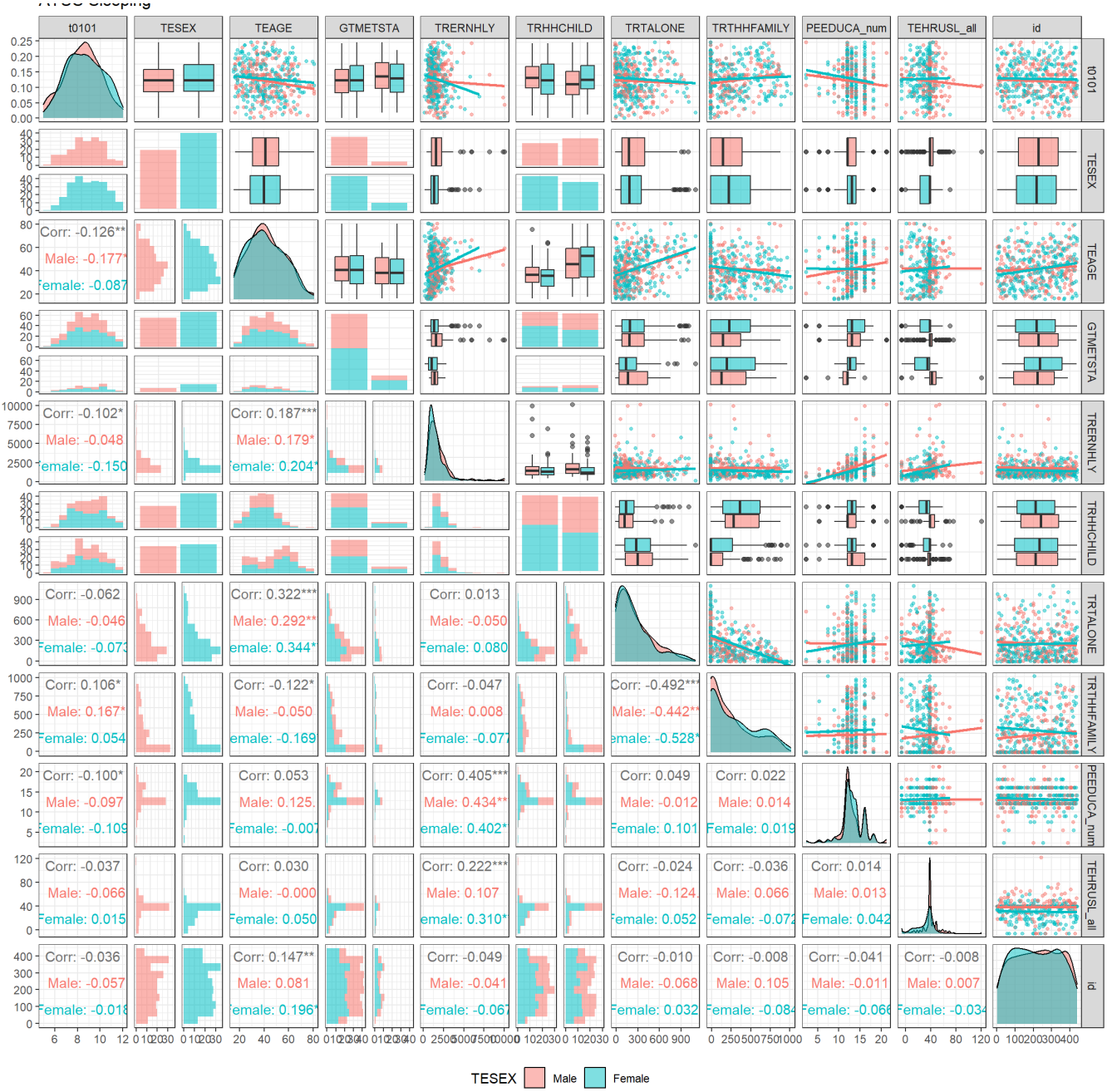
```
## Scatterplot matrix
library(ggplot2)
library(GGally)
```

```
Registered S3 method overwritten by 'GGally':
  method from
  +.gg   ggplot2
```

```
p <-
  ggpairs(
    dat_atus %>% dplyr::select(-TUCASEID)
  , title = "ATUS Sleeping"
  , mapping = ggplot2::aes(colour = TESEX, alpha = 0.5)
  , diag  = list(
              continuous =
                wrap(
                  c("densityDiag", "barDiag", "blankDiag")[1]
```

```
                , alpha = 1/2
                )
            , discrete =
                c("barDiag", "blankDiag")[1]
            )
  # scatterplots on top so response as first variable has y on vertical axis
  , upper = list(
              continuous =
                wrap(
                  c("points", "smooth", "smooth_loess", "density", "cor", "blank")[2]
                , se = FALSE
                , alpha = 1/2
                , size = 1
                )
            , discrete =
                c("ratio", "facetbar", "blank")[2]
            , combo =
                wrap(
                  c("box", "box_no_facet", "dot", "dot_no_facet", "facethist", "facet
                #, bins = 10  # for facethist
                )
            )
  , lower = list(
              continuous =
                wrap(
                  c("points", "smooth", "smooth_loess", "density", "cor", "blank")[5]
                #, se = FALSE
                #, alpha = 1/2
                #, size = 1
                )
            , discrete =
                c("ratio", "facetbar", "blank")[2]
            , combo =
                wrap(
                  c("box", "box_no_facet", "dot", "dot_no_facet", "facethist", "facet
                , bins = 10  # for facethist
                )
            )
  , progress = FALSE
  , legend = 1        # create legend
  )
p <- p + theme_bw()
p <- p + theme(legend.position = "bottom")
print(p)
```

ATUS Sleeping



4 Analysis

4.1 Initial model

This is done automatically based on your personalized analysis conditions.

```
# Mean model
if (condition_2_init_model == "Mean") {
  lm_fit_init <-
    lm(
      t0101 ~ 1
```

```
      t0101 ~ 1
    , data = dat_atus
    )
}

# Main-effects model
if (condition_2_init_model == "Main effects") {
  lm_fit_init <-
    lm(
      t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all + TRHHC
    , data = dat_atus
    )
}

# Two-way interaction model
if (condition_2_init_model == "Two-way interaction") {
  lm_fit_init <-
    lm(
      t0101 ~ (TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all + TRHH
    , data = dat_atus
    )
  # If the two-way interaction model has NA coefficients,
  #   then there were probably pairs of categories that had no observations so could
  # In this case, set the argument "singular.ok = TRUE" in the car::Anova() function
}

lm_fit_init
```

```
Call:
lm(formula = t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num +
    TRERNHLY + TEHRUSL_all + TRHHCHILD + TRTALONE + TRTHHFAMILY,
    data = dat_atus)

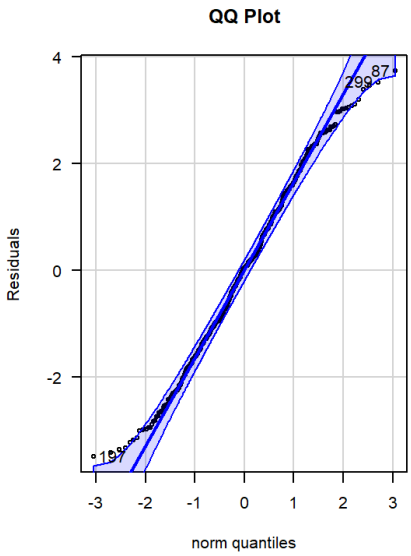
Coefficients:
            (Intercept)              TESEXFemale                    TEAGE
              9.559e+00                1.669e-01               -1.376e-02
GTMETSTANon-metropolitan            PEEDUCA_num                 TRERNHLY
              3.498e-02               -5.483e-02               -4.302e-05
           TEHRUSL_all             TRHHCHILDNo                  TRTALONE
              -9.292e-04               1.511e-01                1.776e-04
           TRTHHFAMILY
              6.672e-04
```

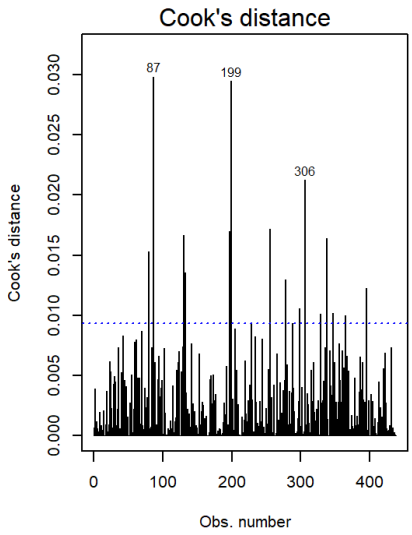
```
car::Anova(lm_fit_init, type = 3, singular.ok = FALSE)
```

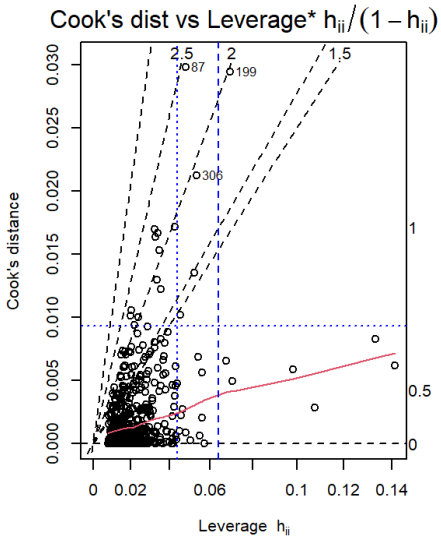
```
Anova Table (Type III tests)

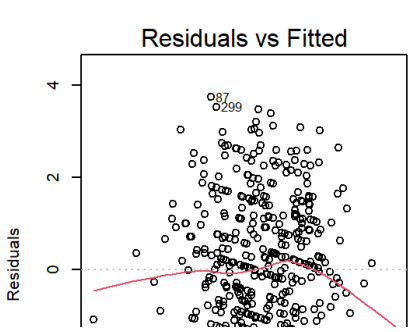
Response: t0101
             Sum Sq  Df  F value  Pr(>F)
(Intercept)  853.80   1 343.4222 < 2e-16 ***
TESEX          2.70   1   1.0867 0.29778
TEAGE         13.50   1   5.4319 0.02024 *
GTMETSTA       0.07   1   0.0278 0.86775
PEEDUCA_num    6.70   1   2.6947 0.10142
TRERNHLY       0.74   1   0.2960 0.58669
TEHRUSL_all    0.07   1   0.0299 0.86286
TRHHCHILD      1.74   1   0.6995 0.40341
TRTALONE       0.51   1   0.2057 0.65036
TRTHHFAMILY   10.04   1   4.0389 0.04509 *
Residuals   1064.07 428
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

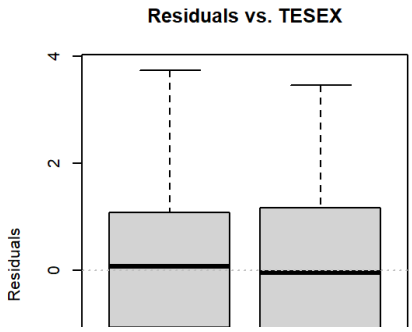
```
# plot diagnostics
e_plot_lm_diagnostics(lm_fit_init)
```

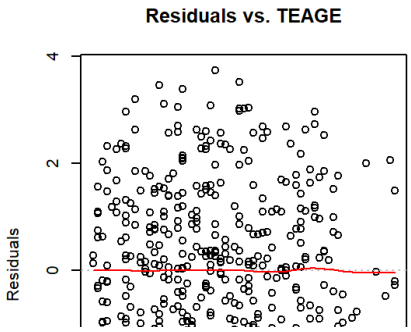


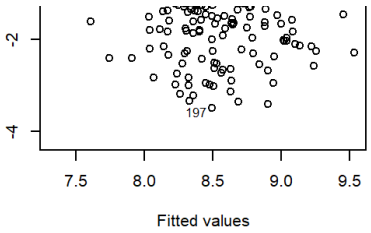


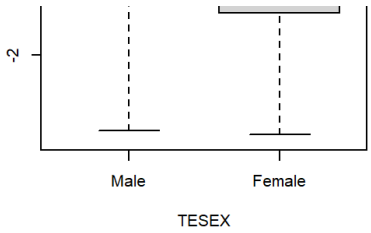


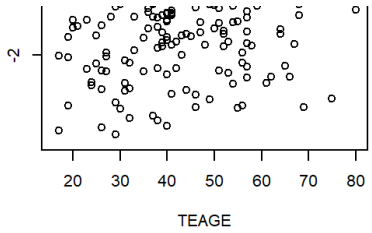


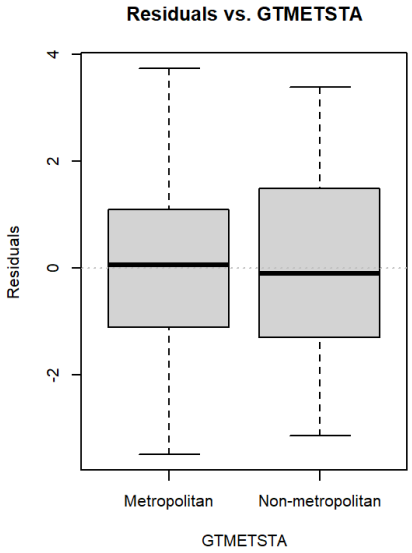


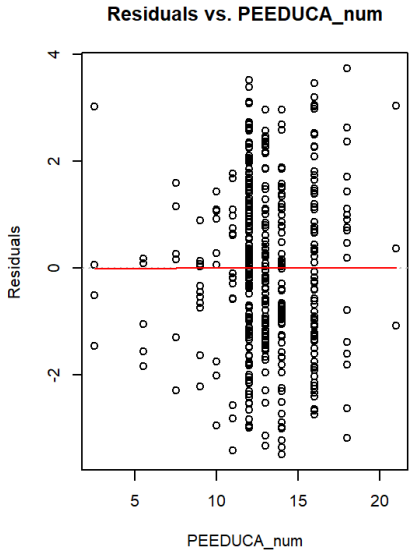


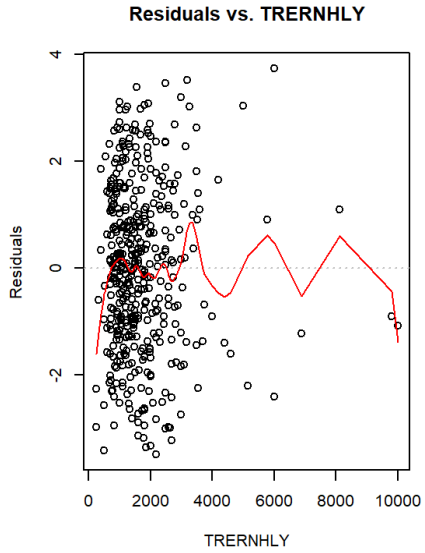

197
7.5
8.0
8.5
9.0
9.5
Fitted values

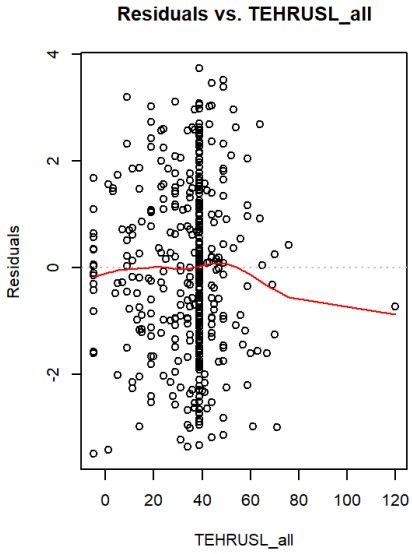

Male
Female
TESEX

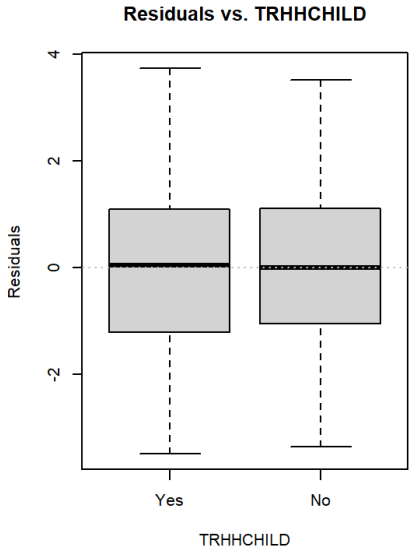

20
30
40
50
60
70
80
TEAGE

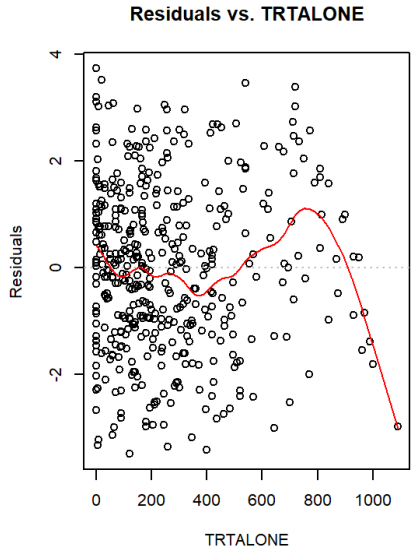

Residuals vs. GTMETSTA
Residuals
Metropolitan
Non-metropolitan
GTMETSTA

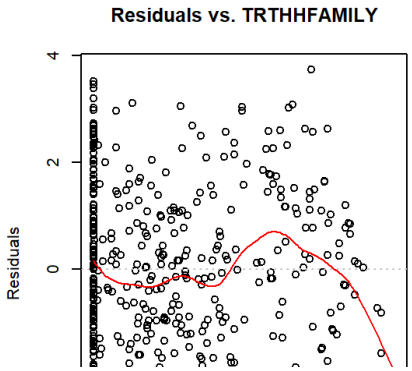

Residuals vs. PEEDUCA_num
Residuals
PEEDUCA_num

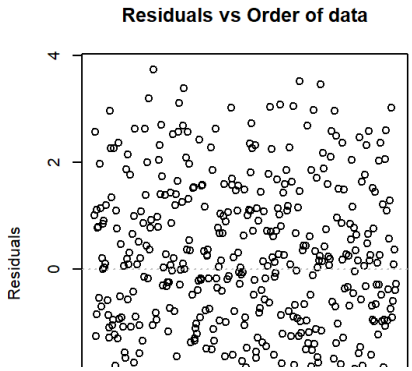

Residuals vs. TRERNHLY
Residuals
0
2000
4000
6000
8000
10000
TRERNHLY

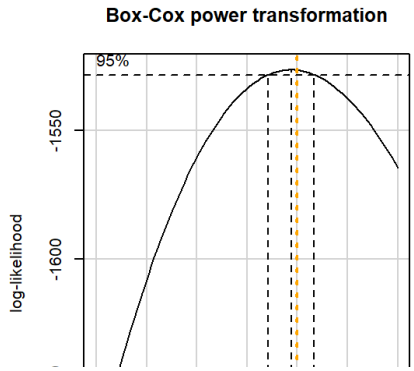

Residuals vs. TEHRUSL_all
Residuals
TEHRUSL_all

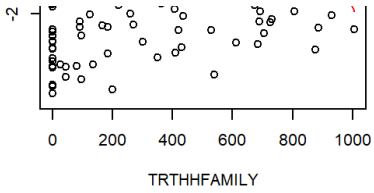

Residuals vs. TRHHCHILD
Residuals
Yes
No
TRHHCHILD

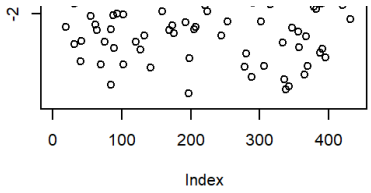

Residuals vs. TRTALONE
Residuals
TRTALONE

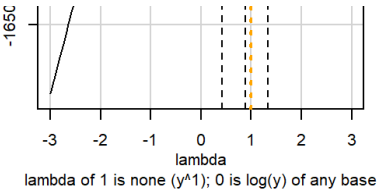

Residuals vs. TRTHHFAMILY
Residuals


Residuals vs Order of data
Residuals


Box-Cox power transformation
95%
log-likelihood
-1550
-1600

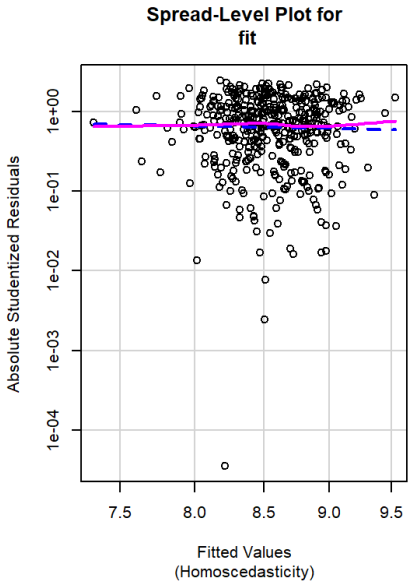


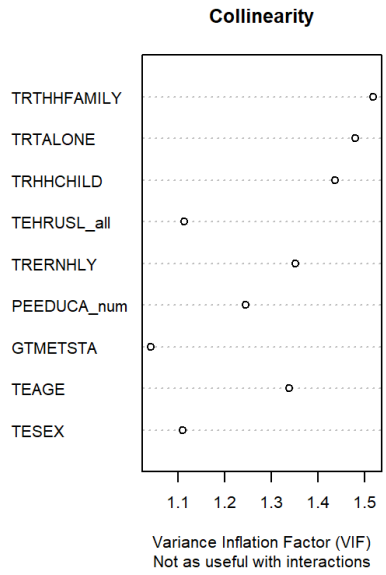


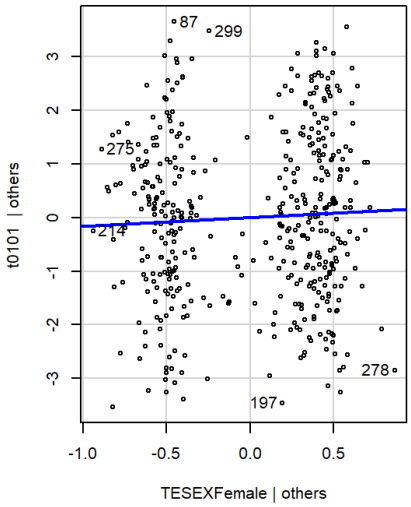


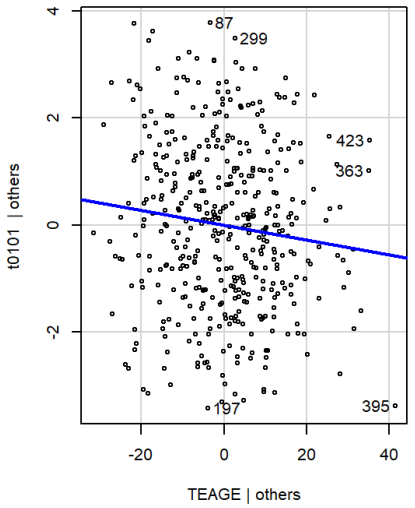

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare = 0.2984774, Df = 1, p = 0.58484
```

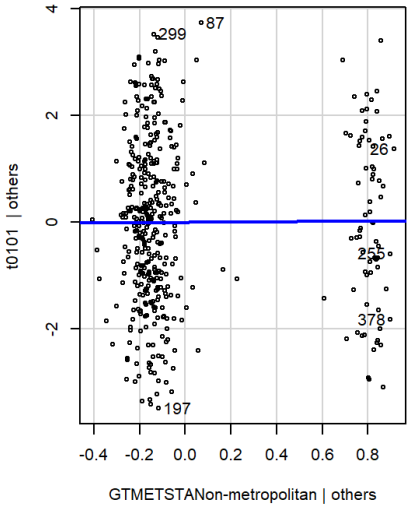
```
Warning in e_plot_lm_diagnostics(lm_fit_init): Note: Collinearity plot
unreliable for predictors that also have interactions in the model.
```

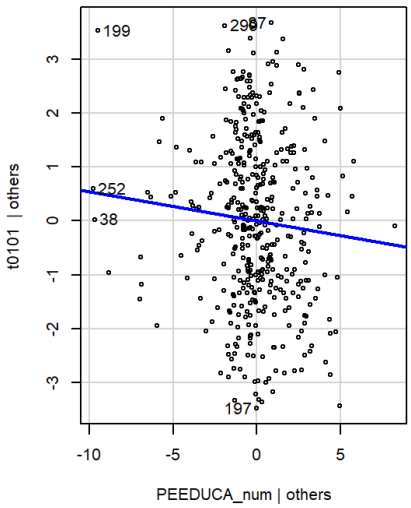


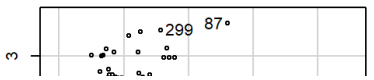


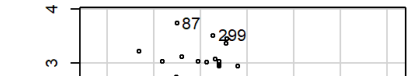


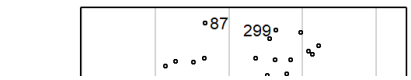


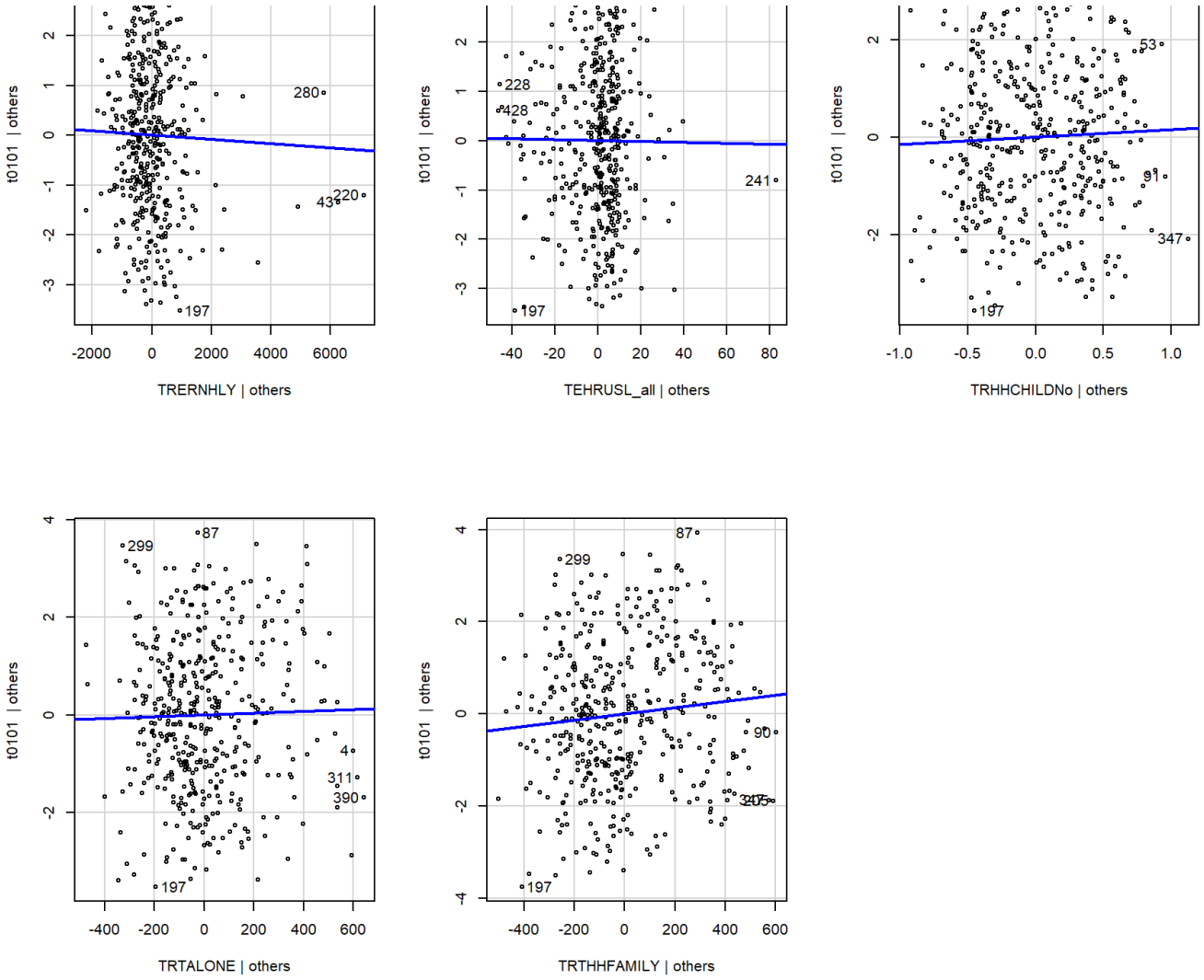












4.2 (3 p) Interpret diagnostics for initial model, resolve issues

QQ Plot: Mostly normal distribution, with only a few observations falling otherwise. After removing one outlier (observation 50) distribution normalized further.

Cook's Distance: Shows a few outliers, but only one (observation 50) shows problematically high leverage. After its removal, the remaining potential outliers do not appear problematic.

Residuals: All residual plots are free of problematic structures.

Box-Cox: Shows no need for transformation.

4.3 Model selection

This is done automatically based on your personalized analysis conditions.

```
# criterion
```

```
# criterion
if (condition_3_criterion == "AIC") {
  AIC_k = 2
}
if (condition_3_criterion == "BIC") {
  AIC_k = log(nrow(dat_atus))
}

## AIC/BIC stepwise selection
# option: test="F" includes additional information
#           for parameter estimate tests that we're familiar with
# option: for BIC, include k=log(nrow( [data.frame name] ))
lm_fit_AIC <-
  step(
    lm_fit_init
  , scope =
      list(
        upper = t0101 ~ (TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_
      , lower = t0101 ~ 1
      )
  , direction = "both"
  , test      = "F"
  , trace     = 1
  , k         = AIC_k     # condition_3_criterion takes effect here
  )
```

```
Start:  AIC=408.78
t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY

                          Df Sum of Sq    RSS    AIC F value    Pr(>F)
+ TRERNHLY:TRTHHFAMILY     1   30.9466 1033.1 397.86 12.7906 0.0003882 ***
+ TRTALONE:TRTHHFAMILY     1   16.0380 1048.0 404.13  6.5344 0.0109260 *
+ TEHRUSL_all:TRHHCHILD    1   14.3900 1049.7 404.82  5.8537 0.0159610 *
+ PEEDUCA_num:TRTHHFAMILY  1   13.3001 1050.8 405.28  5.4048 0.0205501 *
+ PEEDUCA_num:TRTALONE     1   11.5943 1052.5 405.99  4.7039 0.0306447 *
- GTMETSTA                 1    0.0690 1064.1 406.81  0.0278 0.8677507
- TEHRUSL_all              1    0.0743 1064.1 406.81  0.0299 0.8628614
- TRTALONE                 1    0.5115 1064.6 406.99  0.2057 0.6503560
- TRERNHLY                 1    0.7359 1064.8 407.09  0.2960 0.5866940
- TRHHCHILD                1    1.7392 1065.8 407.50  0.6995 0.4034055
+ TEHRUSL_all:TRTHHFAMILY  1    7.0868 1057.0 407.86  2.8629 0.0913727 .
- TESEX                    1    2.7018 1066.8 407.89  1.0867 0.2977829
+ TESEX:TRTHHFAMILY        1    5.7012 1058.4 408.43  2.3001 0.1301019
+ TESEX:TRHHCHILD          1    5.3525 1058.7 408.58  2.1588 0.1424956
+ TEHRUSL_all:TRTALONE     1    5.1382 1058.9 408.66  2.0719 0.1507662
```

```
<none>                                1064.1 408.78
+ GTMETSTA:PEEDUCA_num     1    3.9315 1060.1 409.16  1.5835 0.2089419
+ TEAGE:TRTHHFAMILY        1    3.9046 1060.2 409.17  1.5726 0.2105109
+ TESEX:TRERNHLY           1    3.5403 1060.5 409.32  1.4254 0.2331717
+ TEAGE:TRERNHLY           1    3.2779 1060.8 409.43  1.3194 0.2513343
+ TRHHCHILD:TRTALONE       1    3.2202 1060.8 409.46  1.2962 0.2555519
+ TEAGE:TEHRUSL_all        1    3.0667 1061.0 409.52  1.2342 0.2672195
- PEEDUCA_num              1    6.6993 1070.8 409.53  2.6947 0.1014187
+ GTMETSTA:TRTHHFAMILY     1    2.7945 1061.3 409.63  1.1244 0.2895808
+ TESEX:TEHRUSL_all        1    2.4971 1061.6 409.76  1.0044 0.3168138
+ TRERNHLY:TRHHCHILD       1    1.9778 1062.1 409.97  0.7952 0.3730443
+ TESEX:TEAGE              1    1.9552 1062.1 409.98  0.7860 0.3757964
+ TRERNHLY:TRTALONE        1    1.8087 1062.3 410.04  0.7270 0.3943242
+ GTMETSTA:TRERNHLY        1    1.4120 1062.7 410.20  0.5674 0.4517127
+ TESEX:GTMETSTA           1    1.0965 1063.0 410.33  0.4405 0.5072556
+ PEEDUCA_num:TEHRUSL_all  1    1.0626 1063.0 410.35  0.4268 0.5139011
+ TRHHCHILD:TRTHHFAMILY    1    1.0082 1063.1 410.37  0.4050 0.5248811
+ TRERNHLY:TEHRUSL_all     1    0.8757 1063.2 410.42  0.3517 0.5534566
+ TESEX:PEEDUCA_num        1    0.7574 1063.3 410.47  0.3042 0.5815794
+ GTMETSTA:TEHRUSL_all     1    0.7104 1063.4 410.49  0.2853 0.5935360
+ TEAGE:TRHHCHILD          1    0.2242 1063.8 410.69  0.0900 0.7643412
+ TEAGE:TRTALONE           1    0.2201 1063.8 410.69  0.0883 0.7664359
+ GTMETSTA:TRHHCHILD       1    0.2176 1063.8 410.69  0.0873 0.7677188
+ GTMETSTA:TRTALONE        1    0.2146 1063.8 410.70  0.0861 0.7692914
+ TEAGE:GTMETSTA           1    0.2143 1063.8 410.70  0.0860 0.7694502
+ PEEDUCA_num:TRERNHLY     1    0.1757 1063.9 410.71  0.0705 0.7907167
+ TEAGE:PEEDUCA_num        1    0.1659 1063.9 410.72  0.0666 0.7965086
+ TESEX:TRTALONE           1    0.0326 1064.0 410.77  0.0131 0.9090107
+ PEEDUCA_num:TRHHCHILD    1    0.0002 1064.1 410.78  0.0001 0.9922337
- TRTHHFAMILY              1   10.0412 1074.1 410.90  4.0389 0.0450906 *
- TEAGE                    1   13.5044 1077.6 412.31  5.4319 0.0202363 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=397.86
t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY

                          Df Sum of Sq    RSS    AIC F value    Pr(>F)
+ TRTALONE:TRTHHFAMILY     1   13.9983 1019.1 393.88  5.8514 0.0159831 *
+ TEHRUSL_all:TRTALONE     1   11.3029 1021.8 395.04  4.7122 0.0305005 *
+ TEHRUSL_all:TRHHCHILD    1   10.4786 1022.6 395.39  4.3651 0.0372761 *
- GTMETSTA                 1    0.0153 1033.1 395.86  0.0063 0.9367137
- TEHRUSL_all              1    0.1396 1033.3 395.92  0.0577 0.8103112
- TRTALONE                 1    0.8571 1034.0 396.22  0.3543 0.5520224
```

```
- TRHHCHILD                1    2.1294 1035.2 396.76  0.8801 0.3487043
- TESEX                    1    3.5771 1036.7 397.37  1.4784 0.2246894
+ TESEX:TRERNHLY           1    5.3546 1027.8 397.58  2.2194 0.1370227
<none>                              1033.1 397.86
+ PEEDUCA_num:TRTALONE     1    4.2733 1028.8 398.04  1.7694 0.1841723
+ TRERNHLY:TRTALONE        1    4.0833 1029.0 398.12  1.6904 0.1942488
+ GTMETSTA:PEEDUCA_num     1    3.7100 1029.4 398.28  1.5353 0.2160011
+ TESEX:TRHHCHILD          1    3.1163 1030.0 398.53  1.2889 0.2568966
+ TRHHCHILD:TRTALONE       1    2.6441 1030.5 398.73  1.0931 0.2963803
- PEEDUCA_num              1    6.9010 1040.0 398.77  2.8523 0.0919753 .
+ GTMETSTA:TRERNHLY        1    2.4323 1030.7 398.82  1.0053 0.3165966
+ TESEX:TRTHHFAMILY        1    2.2129 1030.9 398.92  0.9144 0.3394838
+ TEAGE:TEHRUSL_all        1    2.1076 1031.0 398.96  0.8708 0.3512579
+ TRHHCHILD:TRTHHFAMILY    1    1.9894 1031.1 399.01  0.8219 0.3651357
+ PEEDUCA_num:TRTHHFAMILY  1    1.8844 1031.2 399.06  0.7784 0.3781151
+ TRERNHLY:TRHHCHILD       1    1.8300 1031.3 399.08  0.7559 0.3850987
+ TESEX:TEHRUSL_all        1    1.7412 1031.4 399.12  0.7192 0.3968896
+ TEAGE:TRTHHFAMILY        1    1.7205 1031.4 399.13  0.7106 0.3997071
+ PEEDUCA_num:TRERNHLY     1    1.7051 1031.4 399.13  0.7042 0.4018368
+ PEEDUCA_num:TEHRUSL_all  1    1.6075 1031.5 399.17  0.6639 0.4156559
+ PEEDUCA_num:TRHHCHILD    1    1.5506 1031.6 399.20  0.6403 0.4240387
+ TEAGE:PEEDUCA_num        1    1.3910 1031.7 399.27  0.5744 0.4489540
+ GTMETSTA:TRTALONE        1    1.2802 1031.8 399.31  0.5285 0.4676205
+ TEHRUSL_all:TRTHHFAMILY  1    0.9972 1032.1 399.43  0.4116 0.5215047
+ GTMETSTA:TEHRUSL_all     1    0.9425 1032.2 399.46  0.3890 0.5331612
+ GTMETSTA:TRTHHFAMILY     1    0.8367 1032.3 399.50  0.3453 0.5571086
+ TESEX:TEAGE              1    0.7673 1032.3 399.53  0.3166 0.5739324
+ TESEX:PEEDUCA_num        1    0.7628 1032.4 399.53  0.3148 0.5750540
+ TESEX:GTMETSTA           1    0.6501 1032.5 399.58  0.2682 0.6047927
+ TEAGE:GTMETSTA           1    0.5973 1032.5 399.60  0.2464 0.6198502
+ TEAGE:TRHHCHILD          1    0.4478 1032.7 399.67  0.1847 0.6675603
+ TEAGE:TRTALONE           1    0.2837 1032.8 399.74  0.1170 0.7324438
+ TESEX:TRTALONE           1    0.0784 1033.0 399.82  0.0323 0.8573800
+ TEAGE:TRERNHLY           1    0.0347 1033.1 399.84  0.0143 0.9048000
+ TRERNHLY:TEHRUSL_all     1    0.0036 1033.1 399.86  0.0015 0.9694905
+ GTMETSTA:TRHHCHILD       1    0.0017 1033.1 399.86  0.0007 0.9789824
- TEAGE                    1   14.2356 1047.4 401.85  5.8837 0.0156951 *
- TRERNHLY:TRTHHFAMILY     1   30.9466 1064.1 408.78 12.7906 0.0003882 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=393.88
t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY
```

```
                          Df Sum of Sq    RSS    AIC F value   Pr(>F)
+ TEHRUSL_all:TRTALONE     1   12.8814 1006.2 390.31  5.4406 0.020140 *
+ TEHRUSL_all:TRHHCHILD    1   11.8952 1007.2 390.74  5.0192 0.025584 *
- TEHRUSL_all              1    0.0134 1019.1 391.89  0.0056 0.940311
- GTMETSTA                 1    0.0320 1019.1 391.90  0.0134 0.907968
- TRHHCHILD                1    0.9086 1020.0 392.27  0.3798 0.538049
- TESEX                    1    3.2611 1022.4 393.28  1.3631 0.243645
+ TESEX:TRERNHLY           1    5.5531 1013.6 393.49  2.3285 0.127770
+ TEAGE:TRTHHFAMILY        1    5.3303 1013.8 393.58  2.2346 0.135697
+ PEEDUCA_num:TRTALONE     1    4.9858 1014.1 393.73  2.0894 0.149059
<none>                                 1019.1 393.88
+ GTMETSTA:PEEDUCA_num     1    4.2775 1014.9 394.04  1.7913 0.181478
- PEEDUCA_num              1    5.9100 1025.0 394.41  2.4704 0.116749
+ TESEX:TRHHCHILD          1    3.2851 1015.8 394.47  1.3744 0.241716
+ TESEX:TRTHHFAMILY        1    3.2797 1015.8 394.47  1.3721 0.242100
+ TRERNHLY:TRTALONE        1    2.6276 1016.5 394.75  1.0986 0.295170
+ GTMETSTA:TRERNHLY        1    2.2401 1016.9 394.92  0.9362 0.333797
+ TRERNHLY:TRHHCHILD       1    2.1337 1017.0 394.96  0.8917 0.345565
+ PEEDUCA_num:TRTHHFAMILY  1    2.0665 1017.1 394.99  0.8635 0.353282
+ TEHRUSL_all:TRTHHFAMILY  1    2.0131 1017.1 395.02  0.8412 0.359577
+ TEAGE:PEEDUCA_num        1    1.8246 1017.3 395.10  0.7623 0.383117
+ TESEX:TEHRUSL_all        1    1.6355 1017.5 395.18  0.6832 0.408967
+ GTMETSTA:TRTHHFAMILY     1    1.5364 1017.6 395.22  0.6417 0.423553
+ TEAGE:TEHRUSL_all        1    1.4593 1017.7 395.25  0.6094 0.435432
+ PEEDUCA_num:TEHRUSL_all  1    1.4559 1017.7 395.26  0.6080 0.435973
+ PEEDUCA_num:TRHHCHILD    1    1.3941 1017.7 395.28  0.5822 0.445888
+ PEEDUCA_num:TRERNHLY     1    1.3429 1017.8 395.30  0.5608 0.454362
+ GTMETSTA:TRTALONE        1    1.3233 1017.8 395.31  0.5526 0.457685
+ TESEX:PEEDUCA_num        1    0.8141 1018.3 395.53  0.3398 0.560261
+ TEAGE:GTMETSTA           1    0.7647 1018.4 395.55  0.3192 0.572412
+ TESEX:GTMETSTA           1    0.6022 1018.5 395.62  0.2513 0.616445
+ GTMETSTA:TEHRUSL_all     1    0.4966 1018.6 395.67  0.2072 0.649199
+ TESEX:TEAGE              1    0.4045 1018.7 395.71  0.1688 0.681423
+ TRHHCHILD:TRTHHFAMILY    1    0.3883 1018.7 395.71  0.1620 0.687540
+ TEAGE:TRHHCHILD          1    0.2699 1018.9 395.77  0.1126 0.737409
+ TEAGE:TRTALONE           1    0.1365 1019.0 395.82  0.0569 0.811515
+ TESEX:TRTALONE           1    0.1220 1019.0 395.83  0.0509 0.821625
+ TRERNHLY:TEHRUSL_all     1    0.0417 1019.1 395.86  0.0174 0.895105
+ TRHHCHILD:TRTALONE       1    0.0294 1019.1 395.87  0.0122 0.911955
+ TEAGE:TRERNHLY           1    0.0110 1019.1 395.88  0.0046 0.945913
+ GTMETSTA:TRHHCHILD       1    0.0009 1019.1 395.88  0.0004 0.984381
- TEAGE                    1   13.3711 1032.5 397.59  5.5892 0.018519 *
- TRTALONE:TRTHHFAMILY     1   13.9983 1033.1 397.86  5.8514 0.015983 *
- TRERNHLY:TRTHHFAMILY     1   28.9068 1048.0 404.13 12.0832 0.000561 ***
---
```

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

Step:  AIC=390.31
t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE

                          Df Sum of Sq     RSS    AIC F value    Pr(>F)
+ TEHRUSL_all:TRHHCHILD    1    19.432  986.81 383.77  8.3491 0.0040567 **
+ TEHRUSL_all:TRTHHFAMILY  1     9.187  997.05 388.29  3.9069 0.0487363 *
- GTMETSTA                 1     0.072 1006.31 388.34  0.0305 0.8613411
- TRHHCHILD                1     0.478 1006.72 388.52  0.2021 0.6532964
+ TESEX:TRERNHLY           1     7.836  998.41 388.89  3.3278 0.0688206 .
- TESEX                    1     2.366 1008.61 389.34  0.9992 0.3180836
+ PEEDUCA_num:TRTALONE     1     5.815 1000.43 389.77  2.4646 0.1171860
<none>                                 1006.24 390.31
+ TEAGE:TEHRUSL_all        1     4.565 1001.68 390.32  1.9321 0.1652531
+ TESEX:TRHHCHILD          1     4.046 1002.20 390.55  1.7117 0.1914695
+ TESEX:TRTHHFAMILY        1     3.886 1002.36 390.62  1.6439 0.2004922
+ GTMETSTA:PEEDUCA_num     1     3.737 1002.50 390.68  1.5804 0.2093966
+ TEAGE:TRTHHFAMILY        1     3.497 1002.74 390.79  1.4788 0.2246361
+ TESEX:TEHRUSL_all        1     3.012 1003.23 391.00  1.2731 0.2598227
+ TRERNHLY:TRHHCHILD       1     2.306 1003.94 391.31  0.9740 0.3242369
+ GTMETSTA:TRERNHLY        1     2.100 1004.14 391.40  0.8865 0.3469587
- PEEDUCA_num              1     7.375 1013.62 391.51  3.1149 0.0782973 .
+ GTMETSTA:TRTHHFAMILY     1     1.818 1004.42 391.52  0.7673 0.3815610
+ PEEDUCA_num:TRTHHFAMILY  1     1.673 1004.57 391.58  0.7061 0.4012118
+ PEEDUCA_num:TEHRUSL_all  1     1.508 1004.73 391.65  0.6364 0.4254761
+ TEAGE:PEEDUCA_num        1     1.386 1004.86 391.71  0.5848 0.4448453
+ TESEX:PEEDUCA_num        1     1.190 1005.05 391.79  0.5019 0.4790562
+ PEEDUCA_num:TRHHCHILD    1     1.160 1005.08 391.80  0.4895 0.4845135
+ GTMETSTA:TEHRUSL_all     1     1.121 1005.12 391.82  0.4728 0.4920676
+ PEEDUCA_num:TRERNHLY     1     1.119 1005.12 391.82  0.4721 0.4923961
+ TESEX:TEAGE              1     0.816 1005.42 391.95  0.3443 0.5576576
+ TEAGE:TRHHCHILD          1     0.363 1005.88 392.15  0.1532 0.6956876
+ TRERNHLY:TRTALONE        1     0.361 1005.88 392.15  0.1520 0.6968533
+ GTMETSTA:TRTALONE        1     0.339 1005.90 392.16  0.1428 0.7056771
+ TRHHCHILD:TRTHHFAMILY    1     0.326 1005.91 392.17  0.1376 0.7108665
+ TEAGE:GTMETSTA           1     0.320 1005.92 392.17  0.1350 0.7134483
+ TESEX:TRTALONE           1     0.222 1006.02 392.21  0.0935 0.7599338
+ TESEX:GTMETSTA           1     0.119 1006.12 392.26  0.0500 0.8231281
- TEAGE                    1     9.142 1015.38 392.27  3.8614 0.0500590 .
+ GTMETSTA:TRHHCHILD       1     0.014 1006.23 392.30  0.0059 0.9388282
+ TRERNHLY:TEHRUSL_all     1     0.003 1006.24 392.31  0.0013 0.9715360
+ TEAGE:TRERNHLY           1     0.001 1006.24 392.31  0.0004 0.9837661
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+ TRHHCHILD:TRTALONE       1     0.000 1006.24 392.31  0.0001 0.9929765
+ TEAGE:TRTALONE           1     0.000 1006.24 392.31  0.0000 0.9994545
- TEHRUSL_all:TRTALONE     1    12.881 1019.12 393.88  5.4406 0.0201396 *
- TRTALONE:TRTHHFAMILY     1    15.577 1021.82 395.04  6.5791 0.0106609 *
- TRERNHLY:TRTHHFAMILY     1    35.335 1041.58 403.43 14.9243 0.0001294 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=383.77
t0101 ~ TESEX + TEAGE + GTMETSTA + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD

                          Df Sum of Sq     RSS    AIC F value    Pr(>F)
- GTMETSTA                 1     0.232  987.04 381.87  0.0995 0.7525890
+ TESEX:TRERNHLY           1     7.213  979.60 382.56  3.1145 0.0783180 .
+ TRERNHLY:TRHHCHILD       1     6.211  980.60 383.00  2.6794 0.1023992
+ PEEDUCA_num:TRTALONE     1     5.353  981.46 383.39  2.3070 0.1295376
- TESEX                    1     3.770  990.58 383.44  1.6198 0.2038163
<none>                               986.81 383.77
+ GTMETSTA:PEEDUCA_num     1     4.171  982.64 383.91  1.7957 0.1809500
+ TEAGE:TRTHHFAMILY        1     3.879  982.93 384.04  1.6694 0.1970418
+ TEHRUSL_all:TRTHHFAMILY  1     2.910  983.90 384.48  1.2509 0.2640155
+ TESEX:TRTHHFAMILY        1     2.677  984.13 384.58  1.1505 0.2840458
+ TESEX:TEHRUSL_all        1     2.588  984.22 384.62  1.1122 0.2922086
+ GTMETSTA:TEHRUSL_all     1     2.570  984.24 384.63  1.1046 0.2938650
+ TEAGE:PEEDUCA_num        1     2.215  984.59 384.79  0.9515 0.3298972
+ PEEDUCA_num:TEHRUSL_all  1     2.159  984.65 384.81  0.9275 0.3360519
- PEEDUCA_num              1     7.224  994.03 384.96  3.1041 0.0788178 .
+ GTMETSTA:TRERNHLY        1     1.797  985.01 384.97  0.7717 0.3801787
+ PEEDUCA_num:TRERNHLY     1     1.628  985.18 385.05  0.6991 0.4035448
+ GTMETSTA:TRTHHFAMILY     1     1.564  985.25 385.07  0.6714 0.4130209
+ PEEDUCA_num:TRTHHFAMILY  1     1.496  985.31 385.10  0.6421 0.4234061
+ TESEX:PEEDUCA_num        1     1.268  985.54 385.21  0.5444 0.4610233
+ TESEX:TRHHCHILD          1     1.023  985.79 385.31  0.4389 0.5080351
+ TEAGE:TRHHCHILD          1     0.950  985.86 385.35  0.4076 0.5235267
+ PEEDUCA_num:TRHHCHILD    1     0.877  985.93 385.38  0.3763 0.5399242
+ TEAGE:GTMETSTA           1     0.513  986.30 385.54  0.2199 0.6393825
+ TRERNHLY:TEHRUSL_all     1     0.395  986.41 385.59  0.1695 0.6807488
+ TRHHCHILD:TRTHHFAMILY    1     0.333  986.48 385.62  0.1426 0.7058508
+ GTMETSTA:TRTALONE        1     0.331  986.48 385.62  0.1418 0.7066791
+ TEAGE:TRERNHLY           1     0.303  986.51 385.63  0.1299 0.7187465
+ TESEX:TRTALONE           1     0.184  986.63 385.69  0.0789 0.7789698
+ TESEX:TEAGE              1     0.152  986.66 385.70  0.0650 0.7989514
+ TRERNHLY:TRTALONE        1     0.072  986.74 385.74  0.0307 0.8609779
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+ TESEX:GTMETSTA           1     0.061  986.75 385.74  0.0263 0.8713239
+ TEAGE:TEHRUSL_all        1     0.042  986.77 385.75  0.0179 0.8936975
+ TRHHCHILD:TRTALONE       1     0.039  986.77 385.75  0.0168 0.8968944
+ TEAGE:TRTALONE           1     0.032  986.78 385.75  0.0139 0.9061004
+ GTMETSTA:TRHHCHILD       1     0.024  986.79 385.76  0.0101 0.9200974
- TEAGE                    1    11.997  998.81 387.06  5.1549 0.0236817 *
- TRTALONE:TRTHHFAMILY     1    18.052 1004.86 389.71  7.7564 0.0055920 **
- TEHRUSL_all:TRHHCHILD    1    19.432 1006.24 390.31  8.3491 0.0040567 **
- TEHRUSL_all:TRTALONE     1    20.418 1007.23 390.74  8.7729 0.0032294 **
- TRERNHLY:TRTHHFAMILY     1    31.960 1018.77 395.73 13.7322 0.0002387 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=381.87
t0101 ~ TESEX + TEAGE + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD

                          Df Sum of Sq     RSS    AIC F value    Pr(>F)
+ TESEX:TRERNHLY           1     7.016  980.03 380.75  3.0352 0.0822007 .
+ TRERNHLY:TRHHCHILD       1     6.229  980.81 381.10  2.6927 0.1015493
- TESEX                    1     3.644  990.68 381.49  1.5689 0.2110542
+ PEEDUCA_num:TRTALONE     1     5.136  981.91 381.59  2.2176 0.1371863
<none>                                  987.04 381.87
+ TEAGE:TRTHHFAMILY        1     3.958  983.08 382.11  1.7069 0.1921008
+ TEHRUSL_all:TRTHHFAMILY  1     2.850  984.19 382.61  1.2276 0.2684928
+ TESEX:TEHRUSL_all        1     2.691  984.35 382.68  1.1592 0.2822373
+ TESEX:TRTHHFAMILY        1     2.675  984.37 382.68  1.1523 0.2836757
+ PEEDUCA_num:TEHRUSL_all  1     2.140  984.90 382.92  0.9212 0.3377051
+ TEAGE:PEEDUCA_num        1     2.113  984.93 382.93  0.9097 0.3407283
- PEEDUCA_num              1     7.033  994.07 382.98  3.0282 0.0825539 .
+ PEEDUCA_num:TRERNHLY     1     1.588  985.45 383.17  0.6832 0.4089494
+ PEEDUCA_num:TRTHHFAMILY  1     1.427  985.61 383.24  0.6141 0.4336937
+ TESEX:PEEDUCA_num        1     1.309  985.73 383.29  0.5632 0.4534089
+ TESEX:TRHHCHILD          1     1.052  985.99 383.40  0.4523 0.5015985
+ PEEDUCA_num:TRHHCHILD    1     0.948  986.09 383.45  0.4075 0.5235864
+ TEAGE:TRHHCHILD          1     0.891  986.15 383.48  0.3833 0.5361778
+ TRERNHLY:TEHRUSL_all     1     0.345  986.70 383.72  0.1481 0.7005724
+ TRHHCHILD:TRTHHFAMILY    1     0.328  986.71 383.73  0.1409 0.7075310
+ TEAGE:TRERNHLY           1     0.280  986.76 383.75  0.1205 0.7287114
+ GTMETSTA                 1     0.232  986.81 383.77  0.0995 0.7525890
+ TESEX:TRTALONE           1     0.194  986.85 383.79  0.0834 0.7729345
+ TESEX:TEAGE              1     0.153  986.89 383.80  0.0658 0.7976680
+ TRERNHLY:TRTALONE        1     0.089  986.95 383.83  0.0382 0.8450654
+ TRHHCHILD:TRTALONE       1     0.048  986.99 383.85  0.0204 0.8863835
+ TEAGE:TEHRUSL_all        1     0.047  986.99 383.85  0.0201 0.8874157
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+ TEAGE:TEHRUSL_all          1     0.047  986.99 385.83  0.0201 0.8874197
+ TEAGE:TRTALONE             1     0.033  987.01 383.86  0.0140 0.9057352
- TEAGE                      1    11.965  999.01 385.15  5.1518 0.0237230 *
- TRTALONE:TRTHHFAMILY       1    17.835 1004.88 387.72  7.6794 0.0058308 **
- TEHRUSL_all:TRHHCHILD      1    19.272 1006.31 388.34  8.2983 0.0041691 **
- TEHRUSL_all:TRTALONE       1    20.289 1007.33 388.78  8.7360 0.0032936 **
- TRERNHLY:TRTHHFAMILY       1    31.856 1018.90 393.78 13.7163 0.0002406 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=380.75
t0101 ~ TESEX + TEAGE + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD +
    TESEX:TRERNHLY

                          Df Sum of Sq     RSS    AIC F value    Pr(>F)
+ TRERNHLY:TRHHCHILD       1     7.313  972.71 379.47  3.1800 0.0752635 .
+ TESEX:TEHRUSL_all        1     5.511  974.51 380.28  2.3922 0.1226929
+ TEAGE:TRTHHFAMILY        1     4.698  975.33 380.64  2.0377 0.1541795
<none>                                  980.03 380.75
+ PEEDUCA_num:TRTALONE     1     4.009  976.02 380.95  1.7373 0.1881886
+ TEHRUSL_all:TRTHHFAMILY  1     3.566  976.46 381.15  1.5448 0.2145978
+ TESEX:TRTHHFAMILY        1     2.804  977.22 381.49  1.2139 0.2711916
- PEEDUCA_num              1     6.487  986.51 381.64  2.8064 0.0946283 .
+ TEAGE:PEEDUCA_num        1     2.474  977.55 381.64  1.0704 0.3014451
- TESEX:TRERNHLY           1     7.016  987.04 381.87  3.0352 0.0822007 .
+ PEEDUCA_num:TEHRUSL_all  1     1.423  978.60 382.11  0.6150 0.4333487
+ PEEDUCA_num:TRTHHFAMILY  1     1.259  978.77 382.18  0.5439 0.4612288
+ TESEX:TRHHCHILD          1     1.227  978.80 382.20  0.5303 0.4668747
+ TRERNHLY:TRTALONE        1     1.091  978.93 382.26  0.4716 0.4926104
+ TESEX:TEAGE              1     0.880  979.15 382.35  0.3800 0.5379264
+ PEEDUCA_num:TRHHCHILD    1     0.699  979.33 382.43  0.3020 0.5828939
+ TEAGE:TRHHCHILD          1     0.698  979.33 382.44  0.3015 0.5832416
+ GTMETSTA                 1     0.429  979.60 382.56  0.1851 0.6672053
+ PEEDUCA_num:TRERNHLY     1     0.308  979.72 382.61  0.1329 0.7156141
+ TRHHCHILD:TRTHHFAMILY    1     0.253  979.77 382.63  0.1091 0.7413540
+ TESEX:TRTALONE           1     0.248  979.78 382.64  0.1070 0.7437534
+ TRHHCHILD:TRTALONE       1     0.154  979.87 382.68  0.0663 0.7968871
+ TEAGE:TRERNHLY           1     0.102  979.92 382.70  0.0441 0.8337694
+ TEAGE:TEHRUSL_all        1     0.083  979.94 382.71  0.0359 0.8497263
+ TRERNHLY:TEHRUSL_all     1     0.083  979.94 382.71  0.0356 0.8503323
+ TEAGE:TRTALONE           1     0.036  979.99 382.73  0.0154 0.9011512
+ TESEX:PEEDUCA_num        1     0.002  980.02 382.75  0.0011 0.9741611
- TEAGE                    1    10.681  990.71 383.50  4.6211 0.0321464 *
- TRTALONE:TRTHHFAMILY     1    18.079  998.10 386.75  7.8218 0.0053968 **
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- TEHRUSL_all:TRHHCHILD    1    18.586  998.61 386.98  8.0409 0.0047922 **
- TEHRUSL_all:TRTALONE     1    22.662 1002.69 388.76  9.8047 0.0018612 **
- TRERNHLY:TRTHHFAMILY     1    34.498 1014.52 393.90 14.9251 0.0001294 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=379.47
t0101 ~ TESEX + TEAGE + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD +
    TESEX:TRERNHLY + TRERNHLY:TRHHCHILD

                          Df Sum of Sq     RSS    AIC F value    Pr(>F)
+ TESEX:TEHRUSL_all        1     4.893  967.82 379.26  2.1335  0.144858
+ TEAGE:TRTHHFAMILY        1     4.771  967.94 379.31  2.0799  0.149991
+ PEEDUCA_num:TRTALONE     1     4.530  968.18 379.42  1.9743  0.160723
<none>                                  972.71 379.47
+ TESEX:TRTHHFAMILY        1     2.822  969.89 380.19  1.2280  0.268433
+ TEHRUSL_all:TRTHHFAMILY  1     2.458  970.26 380.36  1.0690  0.301760
- PEEDUCA_num              1     6.647  979.36 380.45  2.8907  0.089828 .
+ TESEX:TRHHCHILD          1     1.676  971.04 380.71  0.7285  0.393867
- TRERNHLY:TRHHCHILD       1     7.313  980.03 380.75  3.1800  0.075264 .
+ PEEDUCA_num:TRTHHFAMILY  1     1.304  971.41 380.88  0.5666  0.452052
+ TESEX:TEAGE              1     1.070  971.64 380.99  0.4648  0.495748
+ TEAGE:PEEDUCA_num        1     1.068  971.64 380.99  0.4639  0.496158
+ TEAGE:TRERNHLY           1     0.866  971.85 381.08  0.3762  0.539966
- TESEX:TRERNHLY           1     8.099  980.81 381.10  3.5220  0.061246 .
+ PEEDUCA_num:TEHRUSL_all  1     0.667  972.05 381.17  0.2897  0.590687
+ TESEX:TRTALONE           1     0.440  972.27 381.27  0.1910  0.662311
+ GTMETSTA                 1     0.420  972.29 381.28  0.1822  0.669706
+ TRERNHLY:TEHRUSL_all     1     0.341  972.37 381.31  0.1480  0.700683
+ TRHHCHILD:TRTHHFAMILY    1     0.268  972.45 381.35  0.1163  0.733259
+ TRHHCHILD:TRTALONE       1     0.234  972.48 381.36  0.1016  0.750055
+ TEAGE:TRTALONE           1     0.089  972.62 381.43  0.0384  0.844739
+ TRERNHLY:TRTALONE        1     0.083  972.63 381.43  0.0359  0.849776
+ TESEX:PEEDUCA_num        1     0.070  972.64 381.44  0.0304  0.861635
+ TEAGE:TRHHCHILD          1     0.064  972.65 381.44  0.0276  0.868179
+ PEEDUCA_num:TRERNHLY     1     0.041  972.67 381.45  0.0176  0.894516
+ TEAGE:TEHRUSL_all        1     0.033  972.68 381.45  0.0142  0.905326
+ PEEDUCA_num:TRHHCHILD    1     0.028  972.69 381.45  0.0122  0.911990
- TEAGE                    1    10.406  983.12 382.13  4.5254  0.033973 *
- TRTALONE:TRTHHFAMILY     1    19.135  991.85 386.00  8.3211  0.004119 **
- TEHRUSL_all:TRHHCHILD    1    22.832  995.54 387.63  9.9288  0.001743 **
- TEHRUSL_all:TRTALONE     1    24.472  997.19 388.35 10.6421  0.001195 **
- TRERNHLY:TRTHHFAMILY     1    41.696 1014.41 395.85 18.1323 2.541e-05 ***
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=379.26
t0101 ~ TESEX + TEAGE + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD +
    TESEX:TRERNHLY + TRERNHLY:TRHHCHILD + TESEX:TEHRUSL_all

                          Df Sum of Sq     RSS    AIC F value    Pr(>F)
+ PEEDUCA_num:TRTALONE     1     5.133  962.69 378.93  2.2447 0.1348181
<none>                                 967.82 379.26
- TESEX:TEHRUSL_all        1     4.893  972.71 379.47  2.1335 0.1448583
+ TEAGE:TRTHHFAMILY        1     3.767  964.05 379.55  1.6452 0.2003137
+ TESEX:TRTHHFAMILY        1     2.954  964.87 379.92  1.2887 0.2569257
- PEEDUCA_num              1     6.361  974.18 380.13  2.7736 0.0965749 .
+ TEHRUSL_all:TRTHHFAMILY  1     2.475  965.35 380.14  1.0795 0.2994161
- TRERNHLY:TRHHCHILD       1     6.694  974.51 380.28  2.9189 0.0882807 .
+ TESEX:TRHHCHILD          1     1.866  965.95 380.41  0.8132 0.3676847
+ PEEDUCA_num:TRTHHFAMILY  1     1.487  966.33 380.59  0.6477 0.4213780
+ TEAGE:TRERNHLY           1     1.376  966.44 380.64  0.5996 0.4391809
+ TESEX:TEAGE              1     1.314  966.51 380.66  0.5725 0.4496801
+ TEAGE:PEEDUCA_num        1     0.854  966.97 380.87  0.3718 0.5423552
+ TESEX:TRTALONE           1     0.727  967.09 380.93  0.3163 0.5741186
+ TRHHCHILD:TRTHHFAMILY    1     0.281  967.54 381.13  0.1224 0.7266188
+ TRERNHLY:TEHRUSL_all     1     0.268  967.55 381.14  0.1166 0.7329671
+ GTMETSTA                 1     0.262  967.56 381.14  0.1139 0.7358723
+ TRHHCHILD:TRTALONE       1     0.250  967.57 381.15  0.1088 0.7417284
+ PEEDUCA_num:TEHRUSL_all  1     0.185  967.64 381.17  0.0804 0.7768689
+ TESEX:PEEDUCA_num        1     0.174  967.65 381.18  0.0759 0.7830985
+ TEAGE:TRHHCHILD          1     0.149  967.67 381.19  0.0647 0.7994004
+ TEAGE:TEHRUSL_all        1     0.056  967.76 381.23  0.0244 0.8759157
+ PEEDUCA_num:TRHHCHILD    1     0.045  967.78 381.24  0.0195 0.8890158
+ PEEDUCA_num:TRERNHLY     1     0.016  967.80 381.25  0.0070 0.9332888
+ TEAGE:TRTALONE           1     0.014  967.81 381.25  0.0061 0.9379103
+ TRERNHLY:TRTALONE        1     0.002  967.82 381.26  0.0010 0.9743657
- TEAGE                    1     9.145  976.96 381.38  3.9874 0.0464845 *
- TESEX:TRERNHLY           1    10.817  978.64 382.13  4.7167 0.0304267 *
- TRTALONE:TRTHHFAMILY     1    19.157  986.98 385.84  8.3532 0.0040488 **
- TEHRUSL_all:TRHHCHILD    1    21.887  989.71 387.05  9.5435 0.0021393 **
- TEHRUSL_all:TRTALONE     1    27.132  994.95 389.37 11.8306 0.0006406 ***
- TRERNHLY:TRTHHFAMILY     1    41.095 1008.92 395.47 17.9189 2.831e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Step:  AIC=378.93
```

```
Step:  AIC=378.93
t0101 ~ TESEX + TEAGE + PEEDUCA_num + TRERNHLY + TEHRUSL_all +
    TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY +
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD +
    TESEX:TRERNHLY + TRERNHLY:TRHHCHILD + TESEX:TEHRUSL_all +
    PEEDUCA_num:TRTALONE

                          Df Sum of Sq    RSS    AIC F value    Pr(>F)
<none>                                  962.69 378.93
+ TEAGE:TRTHHFAMILY        1     4.209 958.48 379.01  1.8444 0.1751595
+ TESEX:TRTHHFAMILY        1     4.000 958.69 379.11  1.7523 0.1863045
+ TEAGE:PEEDUCA_num        1     3.810 958.88 379.19  1.6690 0.1971092
- PEEDUCA_num:TRTALONE     1     5.133 967.82 379.26  2.2447 0.1348181
- TESEX:TEHRUSL_all        1     5.496 968.18 379.42  2.4036 0.1218075
+ TEHRUSL_all:TRTHHFAMILY  1     3.066 959.62 379.53  1.3421 0.2473256
+ TESEX:TRHHCHILD          1     2.369 960.32 379.85  1.0363 0.3092669
+ TESEX:TRTALONE           1     2.094 960.59 379.98  0.9156 0.3391798
+ TESEX:TEAGE              1     1.823 960.86 380.10  0.7968 0.3725484
- TRERNHLY:TRHHCHILD       1     7.192 969.88 380.19  3.1453 0.0768675 .
+ TRERNHLY:TRTALONE        1     1.344 961.34 380.32  0.5872 0.4439333
+ TEAGE:TRERNHLY           1     0.758 961.93 380.58  0.3308 0.5654885
+ GTMETSTA                 1     0.460 962.23 380.72  0.2006 0.6544468
+ TESEX:PEEDUCA_num        1     0.259 962.43 380.81  0.1129 0.7370519
+ TRERNHLY:TEHRUSL_all     1     0.226 962.46 380.83  0.0986 0.7536851
+ TEAGE:TRHHCHILD          1     0.223 962.46 380.83  0.0971 0.7554322
+ TRHHCHILD:TRTHHFAMILY    1     0.220 962.47 380.83  0.0960 0.7568675
+ PEEDUCA_num:TRHHCHILD    1     0.208 962.48 380.83  0.0908 0.7633194
+ TRHHCHILD:TRTALONE       1     0.092 962.60 380.89  0.0399 0.8416894
+ TEAGE:TEHRUSL_all        1     0.087 962.60 380.89  0.0381 0.8454185
+ PEEDUCA_num:TRTHHFAMILY  1     0.033 962.65 380.91  0.0143 0.9048984
+ PEEDUCA_num:TEHRUSL_all  1     0.030 962.66 380.92  0.0131 0.9090008
+ TEAGE:TRTALONE           1     0.005 962.68 380.93  0.0022 0.9624743
+ PEEDUCA_num:TRERNHLY     1     0.001 962.69 380.93  0.0005 0.9828824
- TESEX:TRERNHLY           1     9.540 972.23 381.25  4.1718 0.0417241 *
- TEAGE                    1     9.630 972.32 381.29  4.2112 0.0407766 *
- TRTALONE:TRTHHFAMILY     1    19.913 982.60 385.90  8.7085 0.0033442 **
- TEHRUSL_all:TRHHCHILD    1    21.545 984.23 386.62  9.4218 0.0022830 **
- TEHRUSL_all:TRTALONE     1    28.037 990.72 389.50 12.2610 0.0005120 ***
- TRERNHLY:TRTHHFAMILY     1    33.732 996.42 392.01 14.7515 0.0001415 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

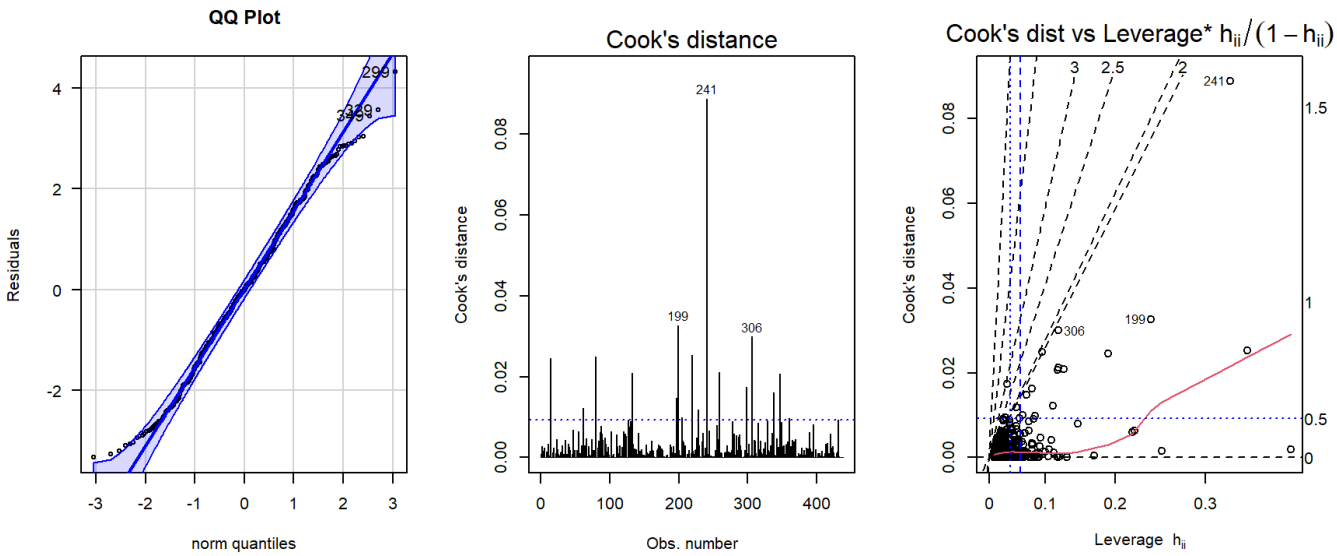
```
lm_fit_final <- lm_fit_AIC

car::Anova(lm_fit_final, type = 3)
```

```
Anova Table (Type III tests)

Response: t0101
                       Sum Sq  Df  F value    Pr(>F)
(Intercept)            387.64   1 169.5222 < 2.2e-16 ***
TESEX                    0.23   1   0.1016 0.7500698
TEAGE                    9.63   1   4.2112 0.0407766 *
PEEDUCA_num              0.07   1   0.0324 0.8572126
TRERNHLY                13.86   1   6.0598 0.0142293 *
TEHRUSL_all              2.84   1   1.2422 0.2656858
TRHHCHILD                5.99   1   2.6180 0.1064036
TRTALONE                 0.00   1   0.0012 0.9720507
TRTHHFAMILY              4.78   1   2.0922 0.1488016
TRERNHLY:TRTHHFAMILY    33.73   1  14.7515 0.0001415 ***
TRTALONE:TRTHHFAMILY    19.91   1   8.7085 0.0033442 **
TEHRUSL_all:TRTALONE    28.04   1  12.2610 0.0005120 ***
TEHRUSL_all:TRHHCHILD   21.54   1   9.4218 0.0022830 **
TESEX:TRERNHLY           9.54   1   4.1718 0.0417241 *
TRERNHLY:TRHHCHILD       7.19   1   3.1453 0.0768675 .
TESEX:TEHRUSL_all        5.50   1   2.4036 0.1218075
PEEDUCA_num:TRTALONE     5.13   1   2.2447 0.1348181
Residuals              962.69 421
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

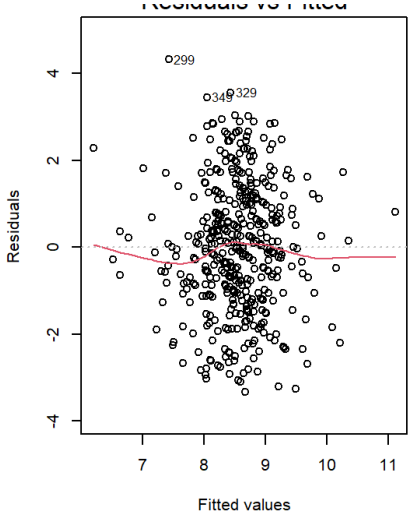
```
# plot diagnostics
e_plot_lm_diagnostics(lm_fit_final)
```

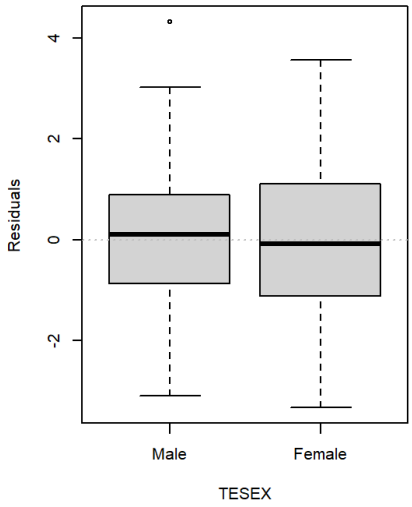


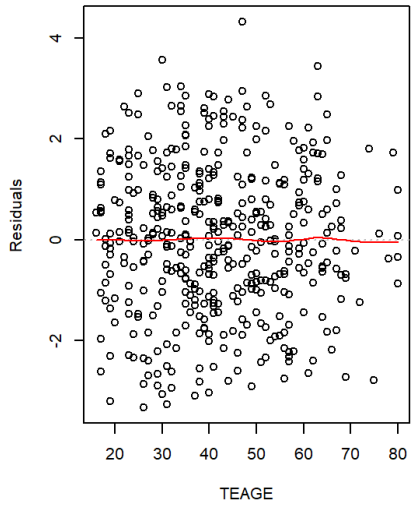
Residuals vs Fitted

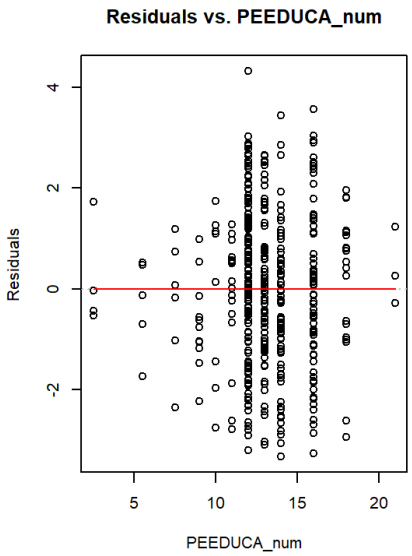
Residuals vs. TESEX

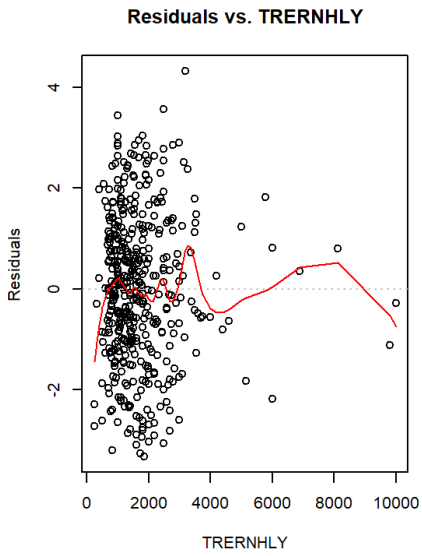
Residuals vs. TEAGE

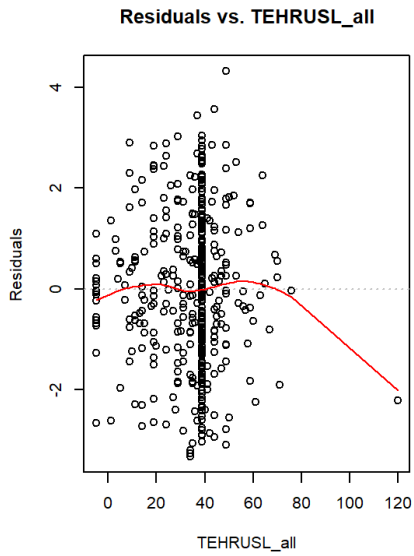


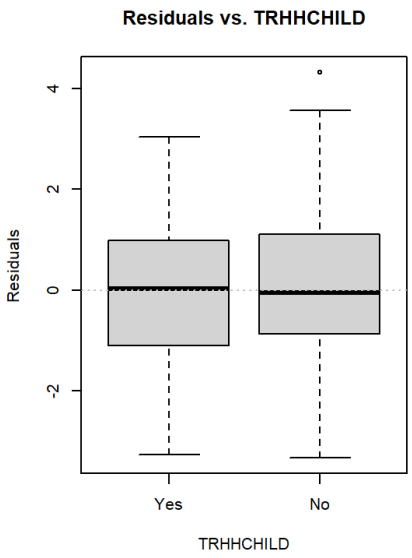


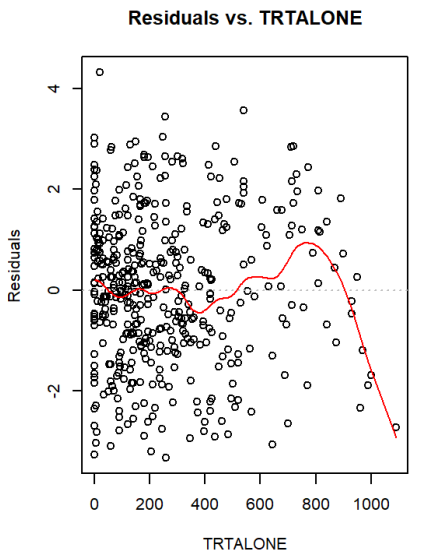


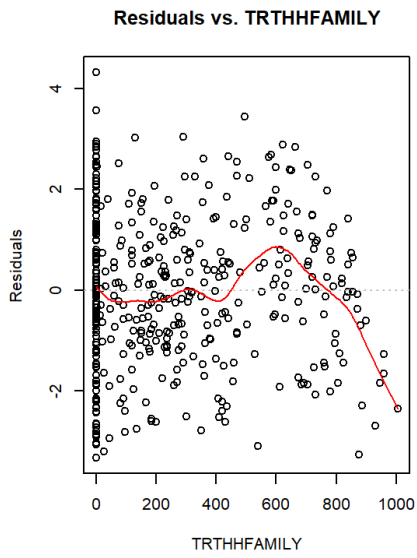








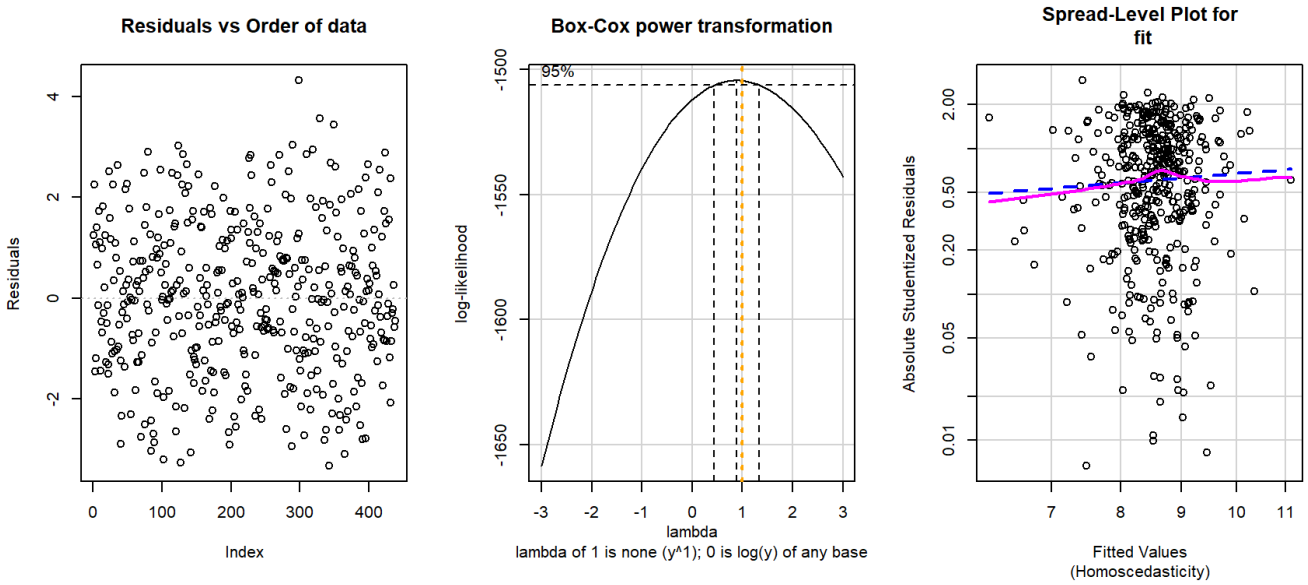




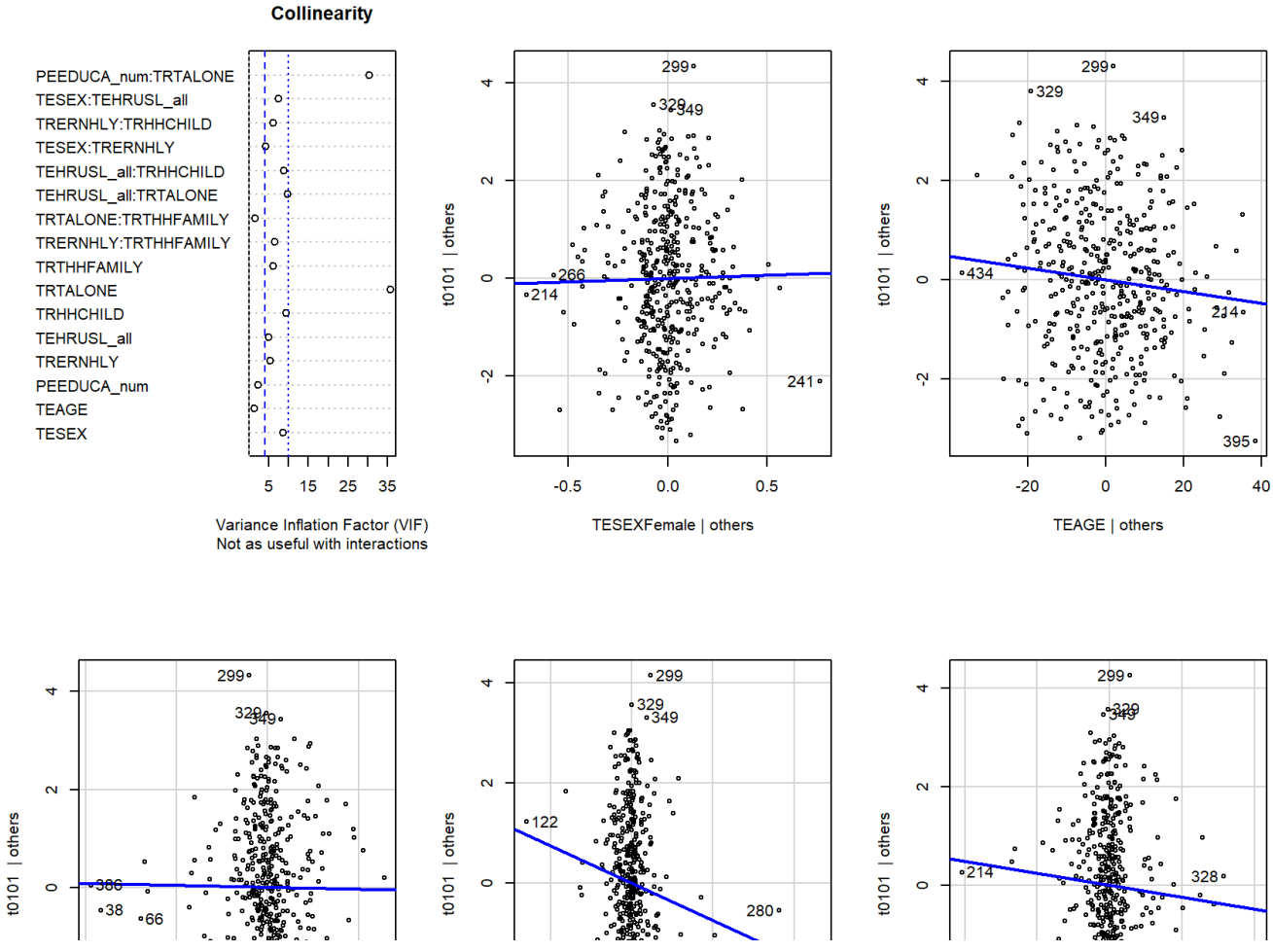

```
Non-constant Variance Score Test
Variance formula: ~ fitted.values
Chisquare    0.06637975   Df    1   p    0.79668
```

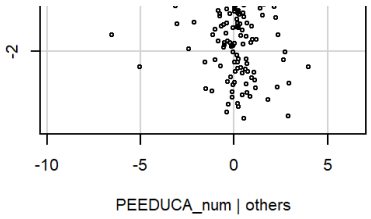
```
Chisquare = 0.06637973, Df = 1, p = 0.79668

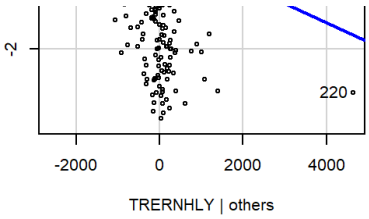
there are higher-order terms (interactions) in this model
consider setting type = 'predictor'; see ?vif
```

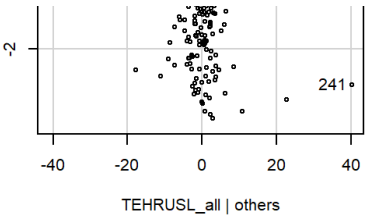


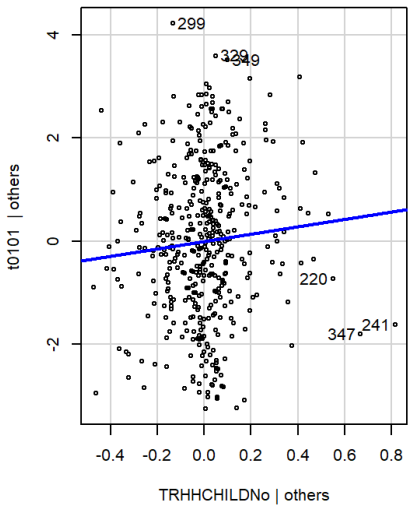

```
Warning in e_plot_lm_diagnostics(lm_fit_final): Note: Collinearity plot
unreliable for predictors that also have interactions in the model.
```

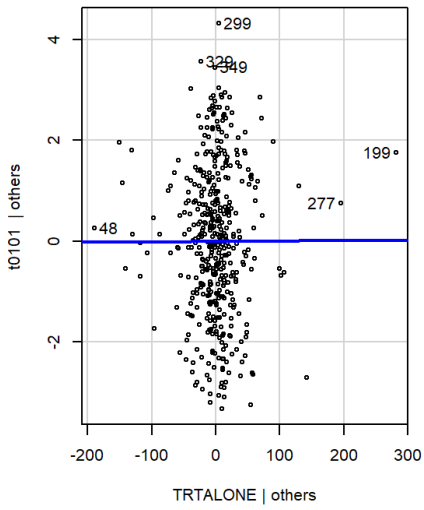


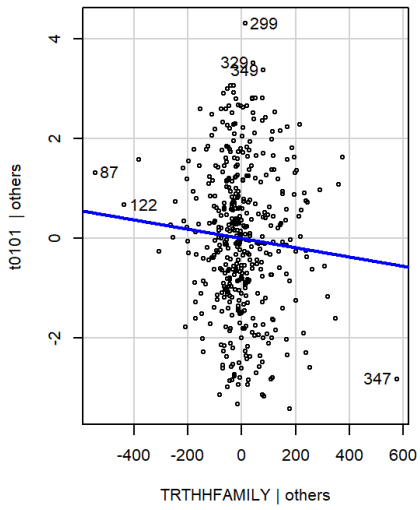

PEEDUCA_num | others

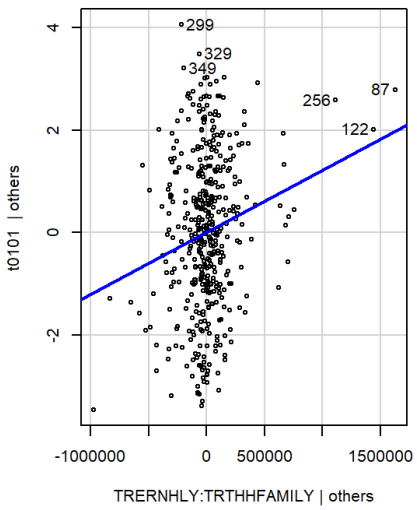

TRERNHLY | others
220

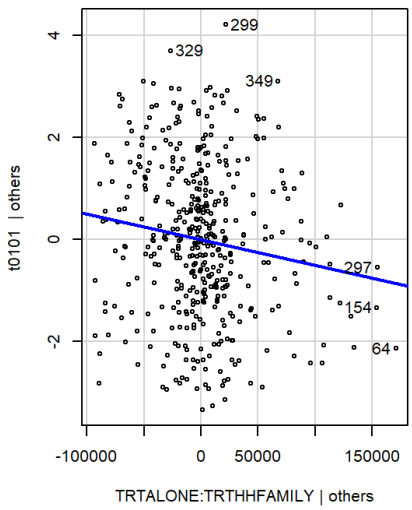

TEHRUSL_all | others
241

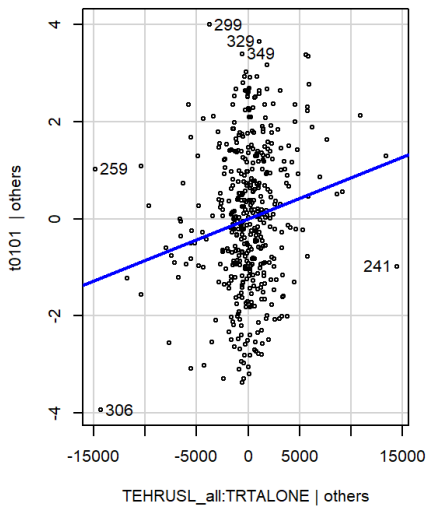

t0101 | others
TRHHCHILDNo | others
299
329
349
220
347
241

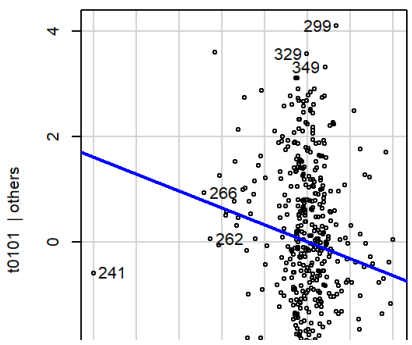

t0101 | others
TRTALONE | others
299
329
349
199
277
48

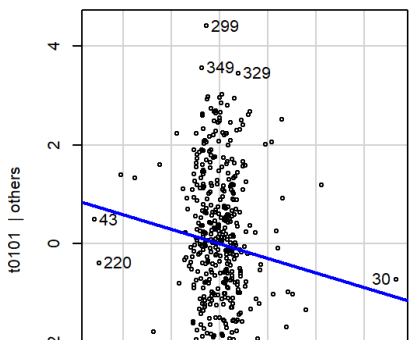

t0101 | others
TRTHHFAMILY | others
299
329
349
87
122
347

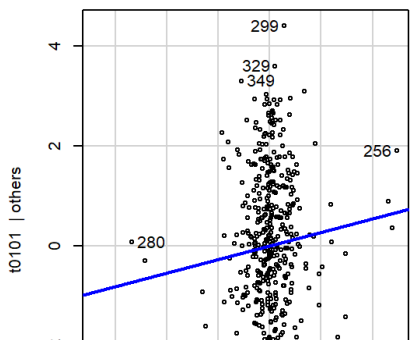

t0101 | others
TRERNHLY:TRTHHFAMILY | others
299
329
349
256
87
122

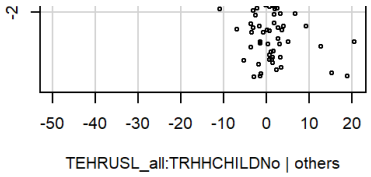

t0101 | others
TRTALONE:TRTHHFAMILY | others
299
329
349
297
154
64

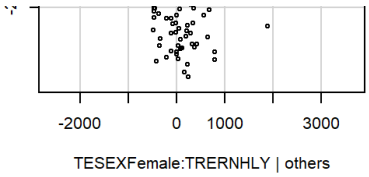

t0101 | others
TEHRUSL_all:TRTALONE | others
299
329
349
259
241
306

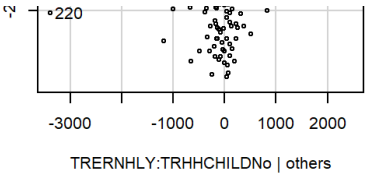

t0101 | others
299
329
349
266
262
241

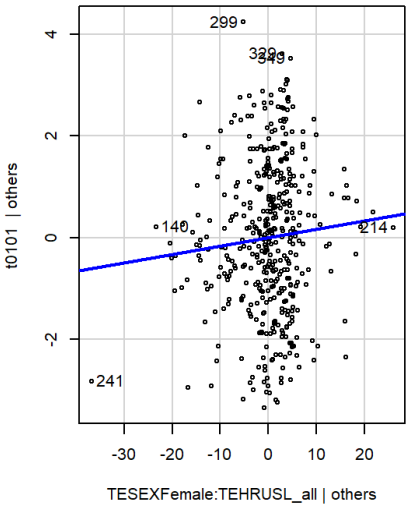

t0101 | others
299
349
329
43
220
30

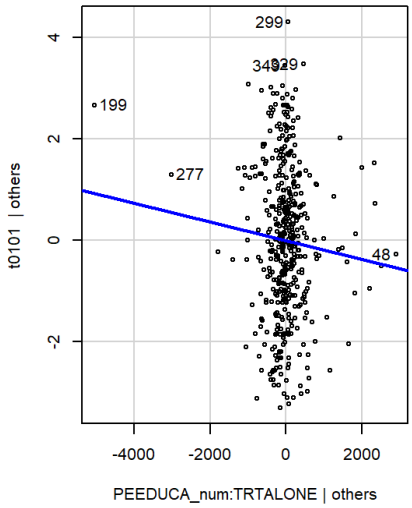

t0101 | others
299
329
349
256
280












```
summary(lm_fit_final)
```

```
Call:
lm(formula = t0101 ~ TESEX + TEAGE + PEEDUCA_num + TRERNHLY + 
    TEHRUSL_all + TRHHCHILD + TRTALONE + TRTHHFAMILY + TRERNHLY:TRTHHFAMILY + 
    TRTALONE:TRTHHFAMILY + TEHRUSL_all:TRTALONE + TEHRUSL_all:TRHHCHILD + 
    TESEX:TRERNHLY + TRERNHLY:TRHHCHILD + TESEX:TEHRUSL_all + 
    PEEDUCA_num:TRTALONE, data = dat_atus)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.3376 -1.0422 -0.0155  1.0580  4.3214 

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)    
(Intercept)             9.831e+00  7.550e-01  13.020  < 2e-16 ***
TESEXFemale             1.369e-01  4.294e-01   0.319 0.750070    
TEAGE                  -1.193e-02  5.815e-03  -2.052 0.040777 *  
PEEDUCA_num            -7.948e-03  4.415e-02  -0.180 0.857213    
TRERNHLY               -3.715e-04  1.509e-04  -2.462 0.014229 *  
TEHRUSL_all            -1.211e-02  1.086e-02  -1.115 0.265686    
TRHHCHILDNo             7.177e-01  4.436e-01   1.618 0.106404    
TRTALONE                6.466e-05  1.844e-03   0.035 0.972051    
```

```
TRTHHFAMILY             -9.313e-04  6.439e-04  -1.446 0.148802
TRERNHLY:TRTHHFAMILY     1.218e-06  3.172e-07   3.841 0.000142 ***
TRTALONE:TRTHHFAMILY    -5.047e-06  1.710e-06  -2.951 0.003344 **
TEHRUSL_all:TRTALONE     8.519e-05  2.433e-05   3.502 0.000512 ***
TEHRUSL_all:TRHHCHILDNo -3.237e-02  1.055e-02  -3.069 0.002283 **
TESEXFemale:TRERNHLY    -2.953e-04  1.446e-04  -2.043 0.041724 *
TRERNHLY:TRHHCHILDNo     2.701e-04  1.523e-04   1.774 0.076867 .
TESEXFemale:TEHRUSL_all  1.650e-02  1.064e-02   1.550 0.121808
PEEDUCA_num:TRTALONE    -1.850e-04  1.235e-04  -1.498 0.134818
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.512 on 421 degrees of freedom
Multiple R-squared:  0.1315,    Adjusted R-squared:  0.09853
F-statistic: 3.985 on 16 and 421 DF,  p-value: 4.578e-07
```

```
lm_fit_criteria <-
  e_lm_model_criteria(
    lm_fit  = lm_fit_final
  , dat_fit = dat_atus
  )
```

4.4 (3 p) Interpret diagnostics for selected model, resolve issues

QQ Plot: A nicely normal distribution.

Cook's Distance: Shows a few outliers, but only one (observation 243) seems to have high leverage. After removing that observation, a single observation (220) appeared potentially problematic. After its removal, no observations appeared problematic.

Residuals: All residual plots are free of problematic structures.

Box-Cox: Shows no need for transformation.

4.5 Model effects/contrasts

```
p_cont <-
  e_plot_model_contrasts(
    fit = lm_fit_final
  , dat_cont = dat_atus
  , choose_contrasts = NULL
  , sw_table_in_plot = TRUE
  , adjust_method = c("none", "tukey", "scheffe", "sidak", "bonferroni", "dunnettx",
```

```
  , CI_level = 0.95
  , sw_glm_scale = c("link", "response")[1]
  , sw_print = FALSE
  , sw_marginal_even_if_interaction = FALSE
  , sw_TWI_plots_keep = c("singles", "both", "all")[1]
  , sw_TWI_both_orientation = c("wide", "tall")[1]
  , sw_plot_quantiles_values = c("quantiles", "values")[1]
  , plot_quantiles = c(0.05, 0.25, 0.5, 0.75, 0.95)
  , sw_quantile_type = 7
  , plot_values = NULL
  , emmip_rg.limit = 1000
  )
```

```
e_plot_model_contrasts: Skipping "TESEX" since involved in interactions.

e_plot_model_contrasts: Skipping "PEEDUCA_num" since involved in interactions.

e_plot_model_contrasts: Skipping "TRERNHLY" since involved in interactions.

e_plot_model_contrasts: Skipping "TEHRUSL_all" since involved in interactions.

e_plot_model_contrasts: Skipping "TRHHCHILD" since involved in interactions.

e_plot_model_contrasts: Skipping "TRTALONE" since involved in interactions.

e_plot_model_contrasts: Skipping "TRTHHFAMILY" since involved in interactions.
```

```
# Since plot interactions have sublists of plots, we want to pull those out
#   into a one-level plot list.
# The code here works for sw_TWI_plots_keep = "singles"
#   which will make each plot the same size in the plot_grid() below.
# For a publications, you'll want to manually choose which plots to show.

# index for plot list,
#   needed since interactions add 2 plots to the list, so the number of terms
#   is not necessarily the same as the number of plots.
i_list <- 0
# initialize a list of plots
p_list <- list()

for (i_term in 1:length(p_cont$plots)) {
  ## i_term = 1

  if ( length(p_cont$plots) == 0 ) {
    print("Skip printing contrasts if intercept-only model")
    next
```

```
  next
}

# extract the name of the plot
n_list <- names(p_cont$plots)[i_term]

# test whether the name has a colon ":"; if so, it's an interaction
if (stringr::str_detect(string = n_list, pattern = stringr::fixed(":"))) {
  # an two-way interaction has two plots

  # first plot
  i_list <- i_list + 1
  p_list[[ i_list ]] <- p_cont$plots[[ i_term ]][[ 1 ]]

  # second plot
  i_list <- i_list + 1
  p_list[[ i_list ]] <- p_cont$plots[[ i_term ]][[ 2 ]]

} else {
  # not an interaction, only one plot

  i_list <- i_list + 1
  p_list[[ i_list ]] <- p_cont$plots[[ i_term ]]

} # if

# Every 4 plots, print them
if (i_list >= 4) {
  p_arranged <-
    cowplot::plot_grid(
      plotlist  = p_list
    , nrow      = NULL
    , ncol      = 2
    , labels    = "AUTO"
    )

  p_arranged %>% print()

  i_list <- 0

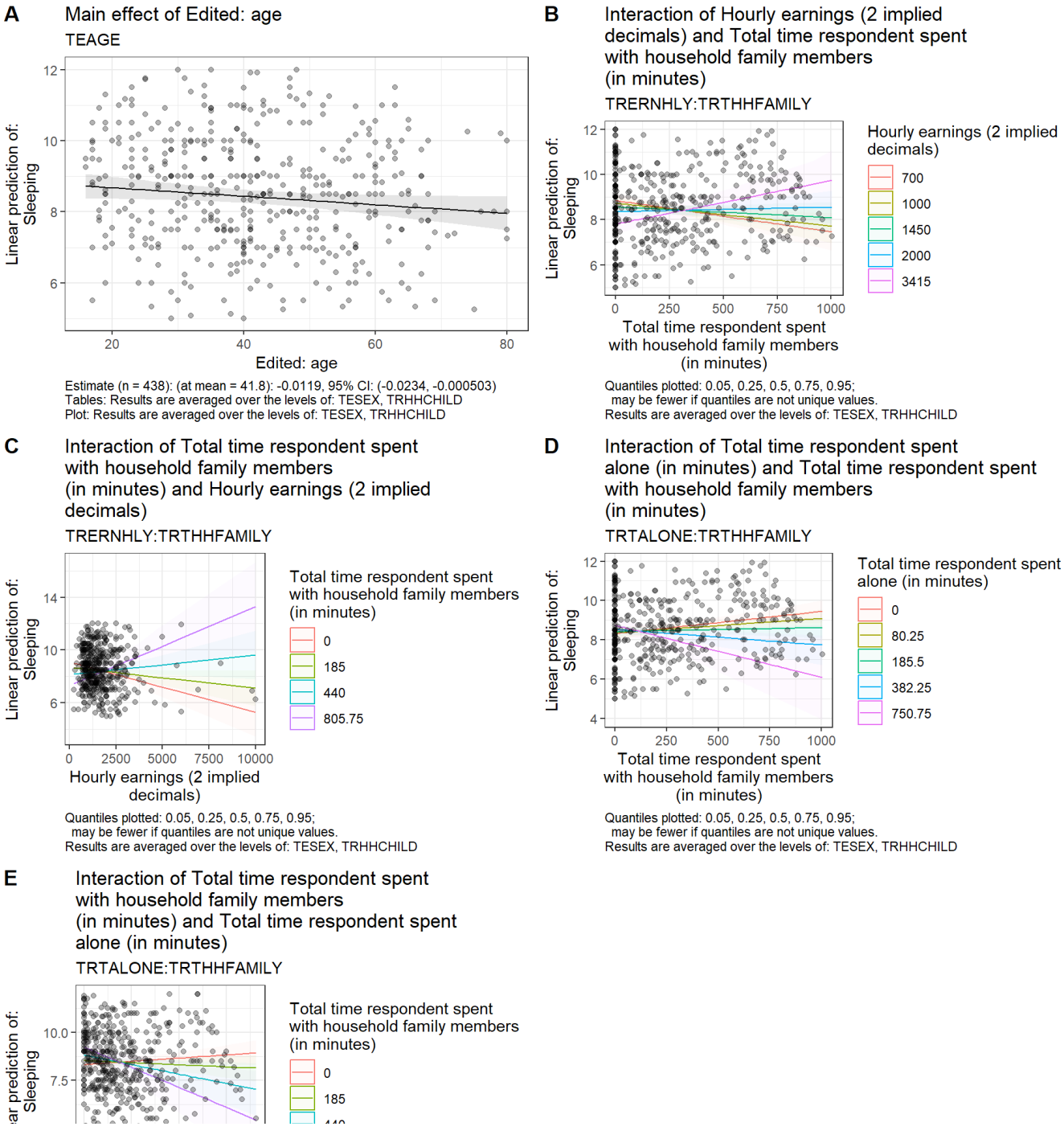
  next
}

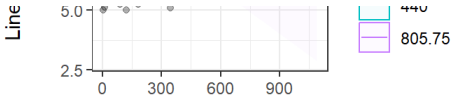
# if last term, print the plots
if (i_term == length(p_cont$plots)) {
  p_arranged <-
```

```
      cowplot::plot_grid(
        plotlist  = p_list
      , nrow      = NULL
      , ncol      = 2
      , labels    = "AUTO"
      )

    p_arranged %>% print()
  }

} # for
```



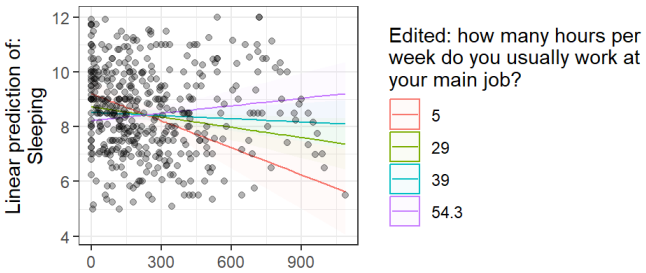


Total time respondent spent alone (in minutes)

Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

A Interaction of Edited: how many hours per week do you usually work at your main job? and Total time respondent spent alone (in minutes)

TEHRUSL_all:TRTALONE

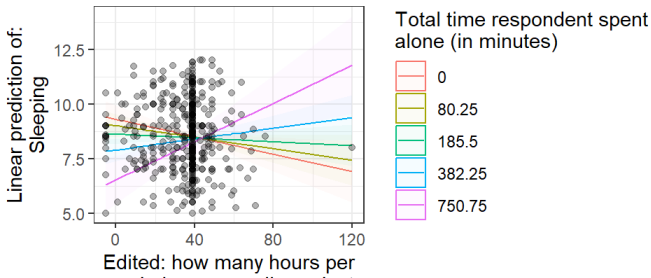


Total time respondent spent alone (in minutes)

Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

B Interaction of Total time respondent spent alone (in minutes) and Edited: how many hours per week do you usually work at your main job?

TEHRUSL_all:TRTALONE

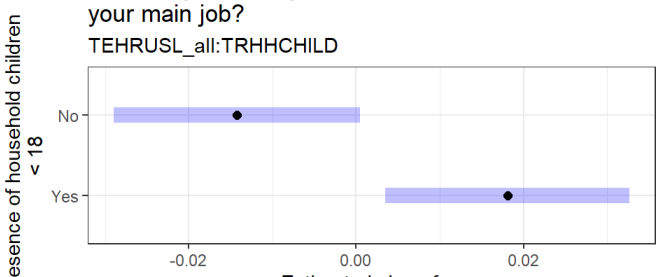


Edited: how many hours per week do you usually work at your main job?

Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

C Interaction of Presence of household children < 18 and Edited: how many hours per week do you usually work at your main job?

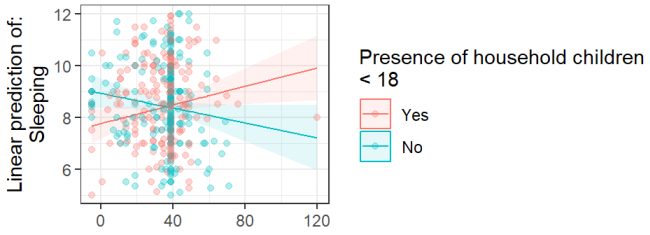
TEHRUSL_all:TRHHCHILD



Estimate (n = 221): Yes = 0.0181, 95% CI: (0.00348, 0.0327)
Estimate (n = 217): No = -0.0143, 95% CI: (-0.029, 0.000431)
Contrast: Yes - No = 0.0324, p-value = 0.0023
Results are averaged over the levels of: TESEX

D Interaction of Presence of household children < 18 and Edited: how many hours per week do you usually work at your main job?

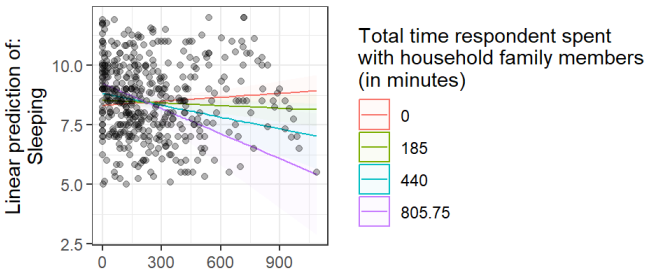
TEHRUSL_all:TRHHCHILD



Estimate (n = 221): Yes = 0.0181, 95% CI: (0.00348, 0.0327)
Estimate (n = 217): No = -0.0143, 95% CI: (-0.029, 0.000431)
Contrast: Yes - No = 0.0324, p-value = 0.0023
Results are averaged over the levels of: TESEX

E Interaction of Total time respondent spent with household family members (in minutes) and Total time respondent spent alone (in minutes)

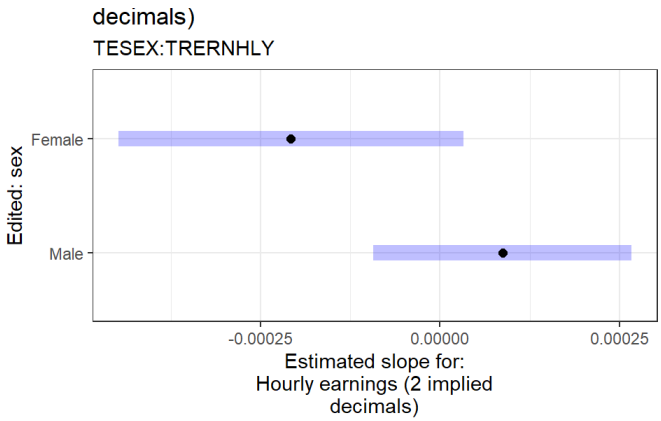
TRTALONE:TRTHHFAMILY



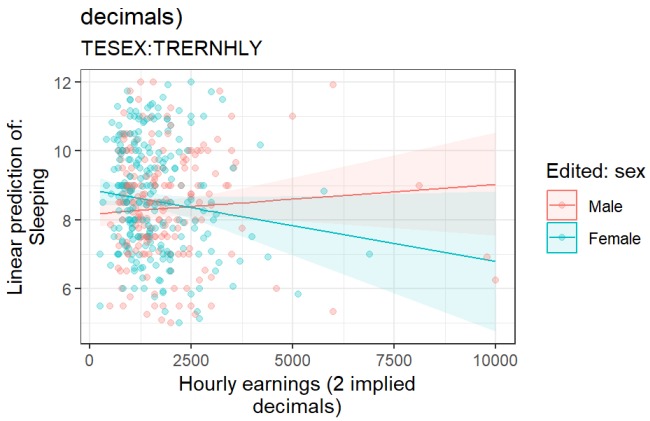
Total time respondent spent with household family members (in minutes)

Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

A Interaction of Edited: sex and Hourly earnings (2 implie **B** Interaction of Edited: sex and Hourly earnings (2 impliec

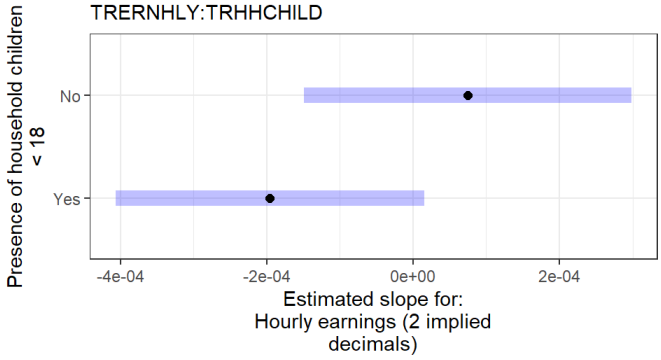


Estimate (n = 191): Male = 8.71e-05, 95% CI: (-9.3e-05, 0.000267)
Estimate (n = 247): Female = -0.000208, 95% CI: (-0.000449, 3.24e-05)
Contrast: Male - Female = 0.000295, p-value = 0.0417
Results are averaged over the levels of: TRHHCHILD



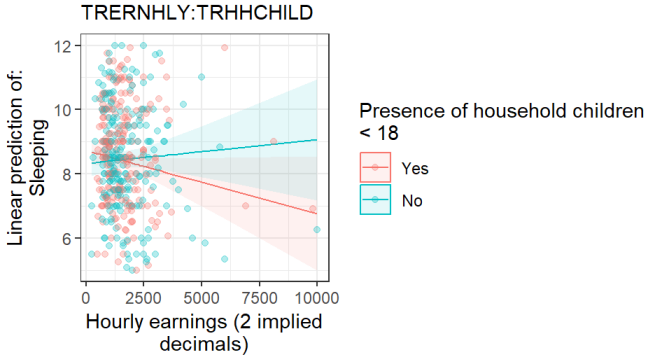
Estimate (n = 191): Male = 8.71e-05, 95% CI: (-9.3e-05, 0.000267)
Estimate (n = 247): Female = -0.000208, 95% CI: (-0.000449, 3.24e-05)
Contrast: Male - Female = 0.000295, p-value = 0.0417
Results are averaged over the levels of: TRHHCHILD

C Interaction of Presence of household children < 18 and Hourly earnings (2 implied decimals)



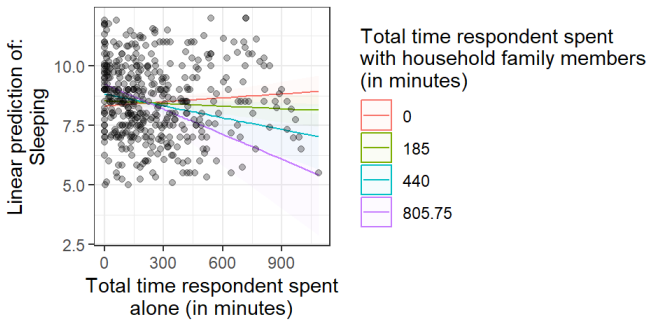
Estimate (n = 221): Yes = -0.000196, 95% CI: (-0.000407, 1.56e-05)
Estimate (n = 217): No = 7.45e-05, 95% CI: (-0.000149, 0.000298)
Contrast: Yes - No = -0.00027, p-value = 0.0769
Results are averaged over the levels of: TESEX

D Interaction of Presence of household children < 18 and Hourly earnings (2 implied decimals)



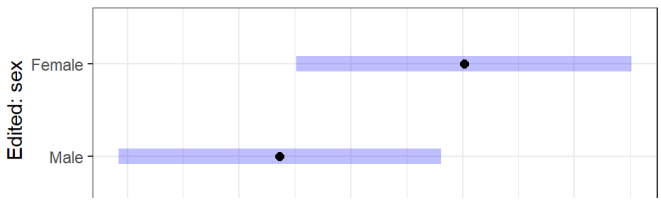
Estimate (n = 221): Yes = -0.000196, 95% CI: (-0.000407, 1.56e-05)
Estimate (n = 217): No = 7.45e-05, 95% CI: (-0.000149, 0.000298)
Contrast: Yes - No = -0.00027, p-value = 0.0769
Results are averaged over the levels of: TESEX

E Interaction of Total time respondent spent with household family members (in minutes) and Total time respondent spent alone (in minutes)

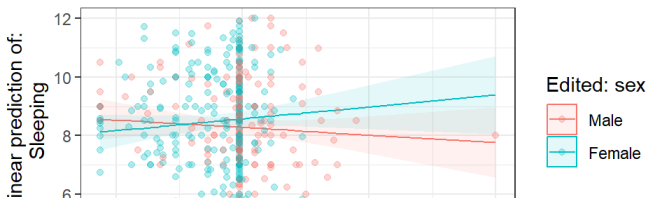


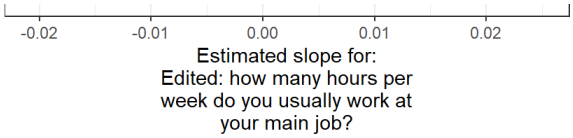
Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

A Interaction of Edited: sex and Edited: how many hours week do you usually work at your main job?

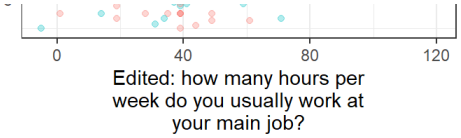


B Interaction of Edited: sex and Edited: how many hours p week do you usually work at your main job?





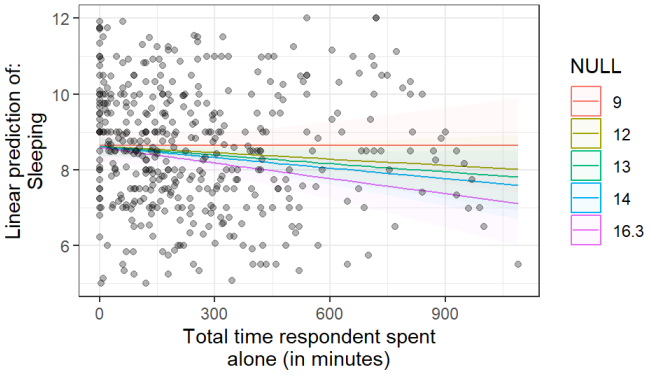
Estimate (n = 191): Male = -0.00636, 95% CI: (-0.0208, 0.00809)
Estimate (n = 247): Female = 0.0101, 95% CI: (-0.00486, 0.0251)
Contrast: Male - Female = -0.0165, p-value = 0.1218
Results are averaged over the levels of: TRHHCHILD



Estimate (n = 191): Male = -0.00636, 95% CI: (-0.0208, 0.00809)
Estimate (n = 247): Female = 0.0101, 95% CI: (-0.00486, 0.0251)
Contrast: Male - Female = -0.0165, p-value = 0.1218
Results are averaged over the levels of: TRHHCHILD

C Interaction of NULL and Total time respondent spent alone (in minutes)

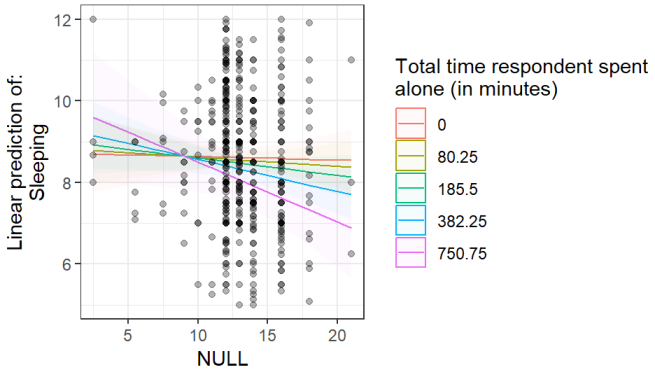
PEEDUCA_num:TRTALONE



Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

D Interaction of Total time respondent spent alone (in minutes) and NULL

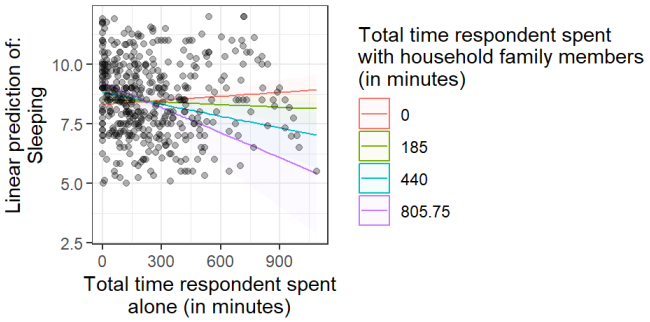
PEEDUCA_num:TRTALONE



Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

E Interaction of Total time respondent spent with household family members (in minutes) and Total time respondent spent alone (in minutes)

TRTALONE:TRTHHFAMILY



Quantiles plotted: 0.05, 0.25, 0.5, 0.75, 0.95;
may be fewer if quantiles are not unique values.
Results are averaged over the levels of: TESEX, TRHHCHILD

4.6 (2 p) Interpret one main effect and one interaction

If you don't have an interaction, interpret a second main effect. Choose the two you think are the most interesting (to you).

1. Main effect: `TEAGE`
   - There is a slight negative correlation between age and amount of sleep.
2. Interaction: `TRTALONE`:`TRTHHFAMILY`
   - The steepest negative correlation between time spent with family members and amount of sleep occurs among those who spend the most time alone, while those who spend the least amount of time alone have a slightly positive correlation between

who spend the least amount of time alone have a slightly positive correlation between amount of time spent with family and amount of sleep. This suggests that sleep is sacrificed for time spent alone more than time spent with family.

5 (1 p) Summarize and share your decisions and results

We will compile all of the results in a google form so that we can see the variability from random sampling, starting model, model selection criteria, and transformations to the response and selected covariates.

Prepare these answers to enter into the **Google Form**.

I've automatically filled in the answers that I could (1, 2, 3, 9, and 10). Please review what you did above to complete the rest, thank you.

1. Random number seed (number): **181818**
2. Starting model: **Main effects**
   - Mean
   - Main effects
   - Two-way interaction
3. Model selection criteria: **AIC**
   - AIC
   - BIC
4. Response variable transformation: **none**
   - none
   - log
   - sqrt (y^0.5)
   - other power transformation
5. Any covariate transformations? (includes any change to a covariate, such as grouping factor levels): **No**
   - Yes
   - No
   - If "Yes" to covariate transformations, list each variable and its transformation on separate lines: "var_name, transformation".
     - var_name1, transformation
     - var_name2, transformation
     - var_name3, transformation
     - var_name4, transformation

6. How many outliers dropped?
    - number: **3**

7. Were you able to satisfy model assumptions? **Yes**
    - Yes
    - No

8. If model assumptions were not met, which were violated, including other issues?
    - Residuals not normal
    - Non-random structure in a residual plot
    - Non-constant variance in a residual plot
    - Influential points (large Cook's D)
    - Outliers

9. Final model criteria statistics:
    - r2 = **0.131535**
    - aic (even if you bic for selection) = **1623.9194176**
    - p (number of model parameters) = **16**
    - df = **421**

10. Terms in model:
    - Initial model: **TESEX, TEAGE, GTMETSTA, PEEDUCA_num, TRERNHLY, TEHRUSL_all, TRHHCHILD, TRTALONE, TRTHHFAMILY**
    - Final model: **TESEX, TEAGE, PEEDUCA_num, TRERNHLY, TEHRUSL_all, TRHHCHILD, TRTALONE, TRTHHFAMILY, TRERNHLY:TRTHHFAMILY, TRTALONE:TRTHHFAMILY, TEHRUSL_all:TRTALONE, TEHRUSL_all:TRHHCHILD, TESEX:TRERNHLY, TRERNHLY:TRHHCHILD, TESEX:TEHRUSL_all, PEEDUCA_num:TRTALONE**