Martel Paper - Daily OA Pain

2024-03-18

Data Wrangling

```
## Load packages
library(tidyverse)
library(ggplot2)
library(tidyr)
library(haven)## This library provides functions to read sav file into R
library(lme4)
library(lmerTest)
```

```
## Read data
data_paper <- read_sav("Dataset; 2024.1.sav")
checkdf3 <- data_paper |>
  subset(ID == 2072) |>
  select(c(ID,
           Level1_Even_DateIn,
           Level1_Even_TimeIn,
           Wave_Day))

## Delete Weird ID 2072 those weird reporting days
data_paper <- data_paper |>
  filter(!(ID == 2072 & Wave_Day >= 7))
```

Adjusting Wave Day

- DT_i combines D_i and T_i: 'DateTime' variable
- DT_0 is the first response 'DateTime' for each patient
- W_i is the adjusted 'Wave_Day' variable
- Add a grace period G for calculating the adjusted W_i, in our case $G = 6$ hours
- Calculate the datetime difference H_i in **hours** from the first response, incorporating the grace period:

$$H_i = DT_i - DT_{i-1}$$

- Then apply the grace period indicator I_i:

$$I_i = \begin{cases} 1 & \text{if } H_i \leq 24 + G \\ \left\lceil \frac{H_i - G}{24} \right\rceil & \text{otherwise} \end{cases}$$

- The initial response for 'Wave_Day' is 1, i.e., $W_0 = 1$, then the adjusted 'Wave_Day' W_i is

$$W_i = \sum_{i=0}^{i-1} I_i$$

```
## Consecutive Days - Grace Period 6 hours
data_paper <- data_paper |>
  mutate(Lev1_DateTimeIn = as.POSIXct(strptime(paste(Level1_Even_DateIn,
                                                     Level1_Even_TimeIn),
                                                format="%Y-%m-%d %H:%M:"))) |>
  arrange(ID, Lev1_DateTimeIn) |>
  group_by(ID) |>
  mutate(
    TimeDiffHours = as.numeric(difftime(Lev1_DateTimeIn,
                                        lag(Lev1_DateTimeIn,
                                            default = first(Lev1_DateTimeIn)),
                                        units = "hours")), # T diff
    WithinGracePeriod = if_else(TimeDiffHours <= 30,
                                1,
                                ceiling((TimeDiffHours - 6) / 24)), # Check grace perio
    Wave_Day_Adjusted = cumsum(WithinGracePeriod) # Adjusted Wave_Day
  ) |>
  ungroup()

###### Check if the above approach is correct ######
checkdf <- data_paper |> select(c(ID,
                                  Lev1_DateTimeIn,
                                  TimeDiffHours,
                                  WithinGracePeriod,
                                  Wave_Day_Adjusted,
                                  Baseline_Demog_BMI))
checkdf2 <- checkdf |> subset(ID == 2072) # Weird ID 2072
max(checkdf$Wave_Day_Adjusted, na.rm = TRUE)
```

```
## [1] 21
```

```
## Fill in the gap of Wave_Day
data_paper2 <- data_paper |>
  group_by(ID) |>
  complete(Wave_Day = 1:14) |>
  ungroup()
```

```
## Check the aberrant values
summary(data_paper2$IndexLev1_NegativeAffect_Total) # Lev 1 Negative Affect
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.000   8.333  20.667  25.189  37.000  97.333    1228
```

```
summary(data_paper2$IndexLev1_Catastrophizing_Total) # Lev 1 Catas
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.000   2.667  12.667  23.085  38.000 100.000    1228
```

```
summary(data_paper2$IndexLev2_QST_BaselinePPTh) # Lev 2 PPThs?
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    67.0   235.5   369.0   395.8   482.5  1200.0    1321
```

```
summary(data_paper2$IndexLev2_QST_TSPAve) # Lev 2 TSP?
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   -2.50    1.50    7.50   13.97   15.00   94.00    1284
```

```
summary(data_paper2$IndexLev2_QST_CpmTrialAve) # Lev 2 CPM?
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   37.56  104.00  119.74  123.10  135.13  251.76    1329
```

```
summary(data_paper2$IndexLev1_PainAverage) # Lev 1 Pain?
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    0.00   24.00   38.00   41.73   59.75  100.00    1234
```

```
###### Check if lagged value is correct ######
data_paper2_check <- data_paper2 |>
  select(c(ID, Wave_Day_Adjusted, IndexLev1_PainAverage, IndexLev1_PainAverage_Lagged))
```

$$APE(t_i) = I(PAIN(t_i) - PAIN(t_i - 1) \geq 20)$$

```
## APE index
data_paper2 <- data_paper2 |>
  group_by(ID) |>
  mutate(APE = ifelse(IndexLev1_PainAverage - IndexLev1_PainAverage_Lagged >= 20, 1, 0))

###### Check if it is correctly coded ######
data_paper2_check <- data_paper2 |>
  select(c(ID, Wave_Day_Adjusted,
           IndexLev1_PainAverage,
           IndexLev1_PainAverage_Lagged,
           APE))
```

For calculating the RPE based on the within person mean, define the indicator that the pain is above the average pain for person i on day t_i. Note that $n_{t_i} = \max t_i$ for patient i.

$$A(t_i) = I\left(PAIN(t_i) > \frac{1}{n_{t_i}} \sum_{t_i=1}^{n_{t_i}} PAIN(t_i)\right)$$

Then define the RPE given $A(t_i) = 1$ for person i on day t_i.

$$RPE(t_i) = I\left(PAIN(t_i) \leq \frac{1}{n_{t_i}} \sum_{t_i=1}^{n_{t_i}} PAIN(t_i)\right) \times A(t_i - 1)$$

```
## RPE Index using within person mean
data_paper2 <- data_paper2 |>
  group_by(ID) |>
  mutate(AVE = mean(IndexLev1_PainAverage, na.rm = TRUE),
         A = ifelse(IndexLev1_PainAverage > AVE, 1, 0),
         A_lag = lag(A),
         Lev1_RPE_useMean = ifelse(A_lag == 1,
                                   ifelse(IndexLev1_PainAverage <= AVE, 1, 0), 0))

###### Check ######
data_paper2_check <- data_paper2 |>
  select(c(ID, Wave_Day_Adjusted, IndexLev1_PainAverage, IndexLev1_PainAverage_Lagged,
           AVE, A, A_lag, Lev1_RPE_useMean))
# 203 RPEs
```

For calculating the RPE based on the APE,

$$RPE(t_i) = I\left(PAIN(t_i) \leq \frac{1}{n_{t_i}} \sum_{t_i=1}^{n_{t_i}} PAIN(t_i)\right) \times APE(t_i - 1)$$

```
## RPE Index using APE
data_paper2 <- data_paper2 |>
  group_by(ID) |>
  mutate(APE_lag = lag(APE),
         Lev1_RPE_useAPE = ifelse(APE_lag == 1,
                                  ifelse(IndexLev1_PainAverage <= 20, 1, 0), 0))

###### Check ######
data_paper2_check <- data_paper2 |>
  select(c(ID, Wave_Day_Adjusted, IndexLev1_PainAverage, IndexLev1_PainAverage_Lagged,
           APE, APE_lag, Lev1_RPE_useAPE))
# 4 RPEs
```

Analysis

```
## Unadjusted APE to Negative Affect
model_APE.NA <- glmer(APE ~ IndexLev1_NegativeAffect_Total + (1|ID), family = binomial()
summary(model_APE.NA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: APE ~ IndexLev1_NegativeAffect_Total + (1 | ID)
##    Data: data_paper2
##
##      AIC      BIC   logLik deviance df.resid
##    451.6    465.7   -222.8    445.6      809
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -0.5907 -0.2780 -0.2335 -0.2048  3.9737
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  ID     (Intercept) 0.7268   0.8525
## Number of obs: 812, groups:  ID, 157
##
## Fixed effects:
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   -3.124537   0.329004  -9.497   <2e-16 ***
## IndexLev1_NegativeAffect_Total  0.014167   0.006951   2.038   0.0415 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## IndxL1_NA_T -0.732
```

```
 ## Unadjusted APE to Catastrophizing
model_APE.Cata <- glmer(APE ~ IndexLev1_Catastrophizing_Total + (1|ID), family = binomia
summary(model_APE.Cata)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: APE ~ IndexLev1_Catastrophizing_Total + (1 | ID)
##    Data: data_paper2
##
##      AIC      BIC   logLik deviance df.resid
```

```
##    444.2    458.3   -219.1    438.2      809
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -0.6057 -0.2835 -0.2176 -0.1865  3.9271
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  ID     (Intercept) 0.7367   0.8583
## Number of obs: 812, groups:  ID, 157
##
## Fixed effects:
##                                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    -3.252303   0.316961 -10.261  < 2e-16 ***
## IndexLev1_Catastrophizing_Total  0.019020   0.005777   3.292 0.000994 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## IndxLv1_C_T -0.720
```

```
## Unadjusted APE to PPThs
model_APE.PPThs <- glmer(APE ~ IndexLev2_QST_BaselinePPTh + (1|ID), family = binomial(),
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.00456593 (tol = 0.002, component 1)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model
##  - Rescale variables?;Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

```
summary(model_APE.PPThs)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: APE ~ IndexLev2_QST_BaselinePPTh + (1 | ID)
##    Data: data_paper2
##
##      AIC      BIC   logLik deviance df.resid
##    415.4    429.2   -204.7    409.4      726
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -0.4954 -0.2973 -0.2563 -0.2168  4.4125
##
```

```
## Random effects:
##  Groups Name        Variance Std.Dev.
##  ID     (Intercept) 0.49     0.7
## Number of obs: 729, groups:  ID, 142
##
## Fixed effects:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                -1.7980758  0.3779896  -4.757 1.97e-06 ***
## IndexLev2_QST_BaselinePPTh -0.0021978  0.0009134  -2.406   0.0161 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## IL2_QST_BPP -0.807
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.00456593 (tol = 0.002, component 1)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
## Model is nearly unidentifiable: large eigenvalue ratio
##  - Rescale variables?
```

```
## Unadjusted APE to TSP
model_APE.TSP <- glmer(APE ~ IndexLev2_QST_TSPAve + (1|ID), family = binomial(), data =
summary(model_APE.TSP)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: APE ~ IndexLev2_QST_TSPAve + (1 | ID)
##    Data: data_paper2
##
##      AIC      BIC   logLik deviance df.resid
##    433.9    447.8   -213.9    427.9      758
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -0.4841 -0.2851 -0.2630 -0.2260  5.6749
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  ID     (Intercept) 0.512    0.7155
## Number of obs: 761, groups:  ID, 146
##
## Fixed effects:
```

```
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)           -2.40370    0.24326  -9.881   <2e-16 ***
## IndexLev2_QST_TSPAve -0.01805    0.01029  -1.754   0.0794 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## IL2_QST_TSP -0.450
```

```
## Unadjusted APE to CPM
model_APE.CPM <- glmer(APE ~ IndexLev2_QST_CpmTrialAve + (1|ID), family = binomial(), da
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, : Model
##  - Rescale variables?
```

```
summary(model_APE.CPM)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: APE ~ IndexLev2_QST_CpmTrialAve + (1 | ID)
##    Data: data_paper2
##
##      AIC      BIC   logLik deviance df.resid
##    415.4    429.2   -204.7    409.4      719
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -0.4942 -0.2957 -0.2365 -0.2284  3.3972
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  ID     (Intercept) 0.7285   0.8536
## Number of obs: 722, groups:  ID, 141
##
## Fixed effects:
##                             Estimate Std. Error z value Pr(>|z|)
## (Intercept)               -2.895586   0.682405  -4.243  2.2e-05 ***
## IndexLev2_QST_CpmTrialAve  0.001580   0.005063   0.312    0.755
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## IL2_QST_CTA -0.939
```

```
## optimizer (Nelder_Mead) convergence code: 0 (OK)
## Model is nearly unidentifiable: very large eigenvalue
##  - Rescale variables?
```