

# Analysis of fetal movements pre/during Covid-19 pandemic

## Preliminaries

```
library(foreign)
library(glmTMB)
library(MASS)
```

## Some summary information

```
covid1 <- read.table("C:/Users/jeinb/OneDrive/Documents/DU/Nadja/Covid/covid1.dat", header=TRUE)
```

## Maternal age

```
range(covid1$maternal_age)
```

```
## [1] 18 37
```

```
mean(covid1$maternal_age)
```

```
## [1] 28.775
```

```
sd(covid1$maternal_age)
```

```
## [1] 5.116527
```

## Maternal BMI

```
range(covid1$maternal_BMI, na.rm=TRUE)
```

```
## [1] 18 33
```

```
sum(is.na(covid1$maternal_BMI))
```

```
## [1] 15
```

## Gestational age

```
range(covid1$gestational_age_atscan_days)
```

```
## [1] 217 231
```

```
mean(covid1$gestational_age_atscan_days)
```

```
## [1] 224.575
```

```
sd(covid1$gestational_age_atscan_days)
```

```
## [1] 3.901923
```

### Fetus gender

```
table(covid1$fetus_gender)
```

```
##  
## female    male  
##      21     19
```

### Pandemic status

```
table(covid1$Pandemic_status)
```

```
##  
## before pandemic during pandemic  
##           20           20
```

## Descriptive analysis for Tables 1 and 2

### Maternal age

```
tapply(covid1$maternal_age, covid1$Pandemic_status, min)
```

```
## before pandemic during pandemic  
##           18           21
```

```
tapply(covid1$maternal_age, covid1$Pandemic_status, max)
```

```
## before pandemic during pandemic  
##           37           36
```

```
tapply(covid1$maternal_age, covid1$Pandemic_status, mean)
```

```
## before pandemic during pandemic  
##      27.55      30.00
```

```
tapply(covid1$maternal_age, covid1$Pandemic_status, sd)
```

```
## before pandemic during pandemic  
##      5.623962      4.352858
```

```
tapply(covid1$gestational_age_atscan_weeks, covid1$Pandemic_status, min)
```

```
## before pandemic during pandemic  
##      31.0      31.3
```

```
tapply(covid1$gestational_age_atscan_weeks, covid1$Pandemic_status, max)
```

```
## before pandemic during pandemic  
##      33      33
```

```
tapply(covid1$gestational_age_atscan_weeks, covid1$Pandemic_status, mean)
```

```
## before pandemic during pandemic  
##      31.985      32.025
```

```
tapply(covid1$gestational_age_atscan_weeks, covid1$Pandemic_status, sd)
```

```
## before pandemic during pandemic  
##      0.6098102      0.5485627
```

```
tapply(covid1$maternal_BMI, covid1$Pandemic_status, min, na.rm=T)
```

```
## before pandemic during pandemic  
##      19.5      18.0
```

```
tapply(covid1$maternal_BMI, covid1$Pandemic_status, max, na.rm=T)
```

```
## before pandemic during pandemic  
##      29      33
```

```
tapply(covid1$maternal_BMI, covid1$Pandemic_status, mean, na.rm=T)
```

```
## before pandemic during pandemic  
##      24.98744      25.44250
```

```
tapply(covid1$maternal_BMI, covid1$Pandemic_status, sd, na.rm=T)
```

```
## before pandemic during pandemic  
##      3.458617      4.388960
```

```
tapply(covid1$HADS_anxiety, covid1$Pandemic_status, min)
```

```
## before pandemic during pandemic  
##           0           2
```

```
tapply(covid1$HADS_anxiety, covid1$Pandemic_status, max)
```

```
## before pandemic during pandemic  
##           9          11
```

```
tapply(covid1$HADS_anxiety, covid1$Pandemic_status, mean)
```

```
## before pandemic during pandemic  
##      3.90      5.65
```

```
tapply(covid1$HADS_anxiety, covid1$Pandemic_status, sd)
```

```
## before pandemic during pandemic  
##      2.613729      3.199918
```

```
tapply(covid1$HADS_depression, covid1$Pandemic_status, min)
```

```
## before pandemic during pandemic  
##           0           1
```

```
tapply(covid1$HADS_depression, covid1$Pandemic_status, max)
```

```
## before pandemic during pandemic  
##           8           6
```

```
tapply(covid1$HADS_depression, covid1$Pandemic_status, mean)
```

```
## before pandemic during pandemic  
##      2.65      3.55
```

```
tapply(covid1$HADS_depression, covid1$Pandemic_status, sd)
```

```
## before pandemic during pandemic  
##      2.058998      1.791060
```

```
tapply(covid1$PSS_perceivedstress, covid1$Pandemic_status, min)
```

```
## before pandemic during pandemic  
##           0           0
```

```
tapply(covid1$PSS_perceivedstress, covid1$Pandemic_status, max)
```

```
## before pandemic during pandemic  
##           20           23
```

```
tapply(covid1$PSS_perceivedstress, covid1$Pandemic_status, mean)
```

```
## before pandemic during pandemic  
##           10.1          11.5
```

```
tapply(covid1$PSS_perceivedstress, covid1$Pandemic_status, sd)
```

```
## before pandemic during pandemic  
##           5.784735       6.202716
```

```
tapply(covid1$Attachment, covid1$Pandemic_status, min)
```

```
## before pandemic during pandemic  
##           70           69
```

```
tapply(covid1$Attachment, covid1$Pandemic_status, max)
```

```
## before pandemic during pandemic  
##           90           90
```

```
tapply(covid1$Attachment, covid1$Pandemic_status, mean)
```

```
## before pandemic during pandemic  
##           81.8          79.5
```

```
tapply(covid1$Attachment, covid1$Pandemic_status, sd)
```

```
## before pandemic during pandemic  
##           5.978910       6.211195
```

## Analysis

Note: The variables `maternal_BMI`, `HC_20weeks_mm` and `maternal_education` are not considered in the analysis which follows. The `maternal_BMI` is missing in 15 out of 40 observations. The `HC_20weeks_mm` is only missing in 2 out of 40 observations, but it is clear from a preliminary analysis that it does not have an

effect. The factor for `education` does not have missing values but its inclusion requires 3 degree of freedom, and also here it is clear from a preliminary analysis that it does not have any effect.

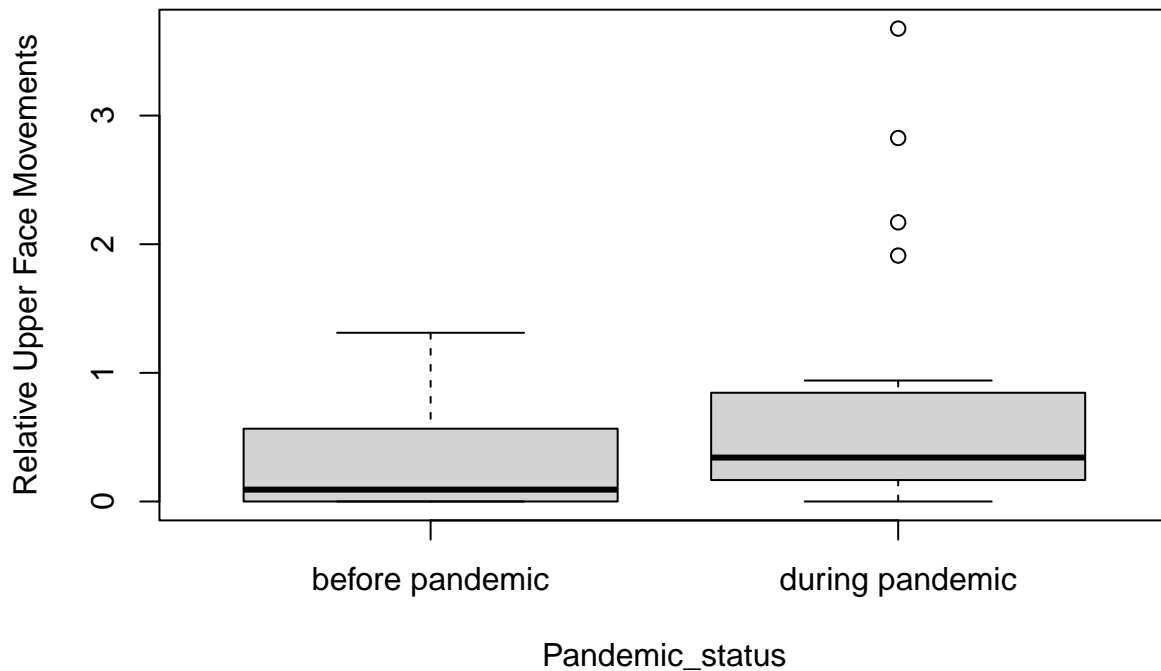
We use a count data regression model to relate the relative number of movements to the several covariates. The models use a negative Binomial response distribution (due to overdispersion when just fitting Poisson), a log-link relating response and predictors, and an additive offset in the form of the logarithm of the codable scanning times for each movement type (in minutes).

We do not consider any of the sub-movement types (such as `LipPucker`) as all of these either led to non-significant effects or did not possess sufficient non=zero data to allow the model to be fitted.

## Upper Face Movements

Boxplot of total face movements per codable scan time (in minutes), before and during the pandemic:

```
boxplot(TotalUpperFaceMovements/Codable_lenght_UpperFaceVisible*60 ~  
        Pandemic_status,  
        ylab="Relative Upper Face Movements", data=covid1)
```



T-test:

```
t.test(TotalUpperFaceMovements/Codable_lenght_UpperFaceVisible*60 ~ Pandemic_status, data=covid1)
```

```
##  
## Welch Two Sample t-test  
##
```

```
## data: TotalUpperFaceMovements/Codable_lenght_UpperFaceVisible * 60 by Pandemic_status
## t = -1.8824, df = 25.268, p-value = 0.07135
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -0.98900489 0.04418404
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 0.3035699 0.7759804
```

Fitted model:

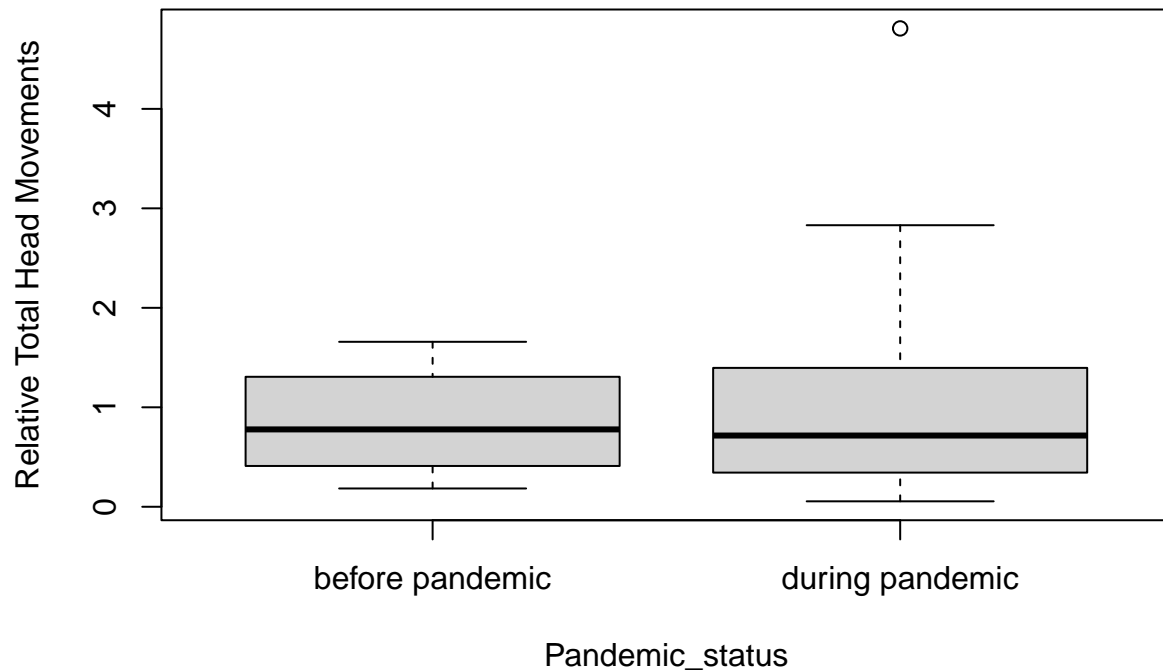
```
summary(fit.UpperFacemove<-glmmTMB(
  TotalUpperFaceMovements~
  Pandemic_status+
  fetus_gender+
  HADS_anxiety+ # remove for mediation analysis
  HADS_depression+PSS_perceivedstress+Attachment+
  maternal_age +
  ## maternal_BMI +
  ## education +
  ## HC_20weeks_mm+
  gestational_age_atscan_days
,
  offset=log(Codable_lenght_UpperFaceVisible), family=nbinom2(link="log"),
  data=covid1
))
```

```
## Family: nbinom2 ( log )
## Formula:
## TotalUpperFaceMovements ~ Pandemic_status + fetus_gender + HADS_anxiety +
## HADS_depression + PSS_perceivedstress + Attachment + maternal_age +
## gestational_age_atscan_days
## Data: covid1
## Offset: log(Codable_lenght_UpperFaceVisible)
##
## AIC BIC logLik deviance df.resid
## 226.2 243.1 -103.1 206.2 30
##
## Dispersion parameter for nbinom2 family (): 0.794
##
## Conditional model:
## Estimate Std. Error z value Pr(>|z|)
## (Intercept) 8.79908 13.85638 0.635 0.52542
## Pandemic_statusduring pandemic 1.20307 0.45390 2.651 0.00804 **
## fetus_gendermale -0.01485 0.41678 -0.036 0.97158
## HADS_anxiety -0.28783 0.14430 -1.995 0.04608 *
## HADS_depression 0.05939 0.14240 0.417 0.67664
## PSS_perceivedstress 0.02548 0.05728 0.445 0.65641
## Attachment -0.08037 0.03874 -2.075 0.03799 *
## maternal_age -0.01546 0.04383 -0.353 0.72421
## gestational_age_atscan_days -0.02939 0.05640 -0.521 0.60228
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## Head movements

Boxplot of total head movements per codable scan time (in minutes), before and during the pandemic:

```
boxplot(TotalHeadmovements/Codable_lenght_HeadVisible*60 ~  
Pandemic_status,  
ylab="Relative Total Head Movements", data=covid1)
```



T-test:

```
t.test(TotalHeadmovements/Codable_lenght_HeadVisible*60~ Pandemic_status, data=covid1)
```

```
##  
## Welch Two Sample t-test  
##  
## data: TotalHeadmovements/Codable_lenght_HeadVisible * 60 by Pandemic_status  
## t = -0.79354, df = 26.104, p-value = 0.4346  
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic  
## 95 percent confidence interval:  
## -0.7797568 0.3453299  
## sample estimates:  
## mean in group before pandemic mean in group during pandemic  
## 0.8412347 1.0584482
```

Fitted model:



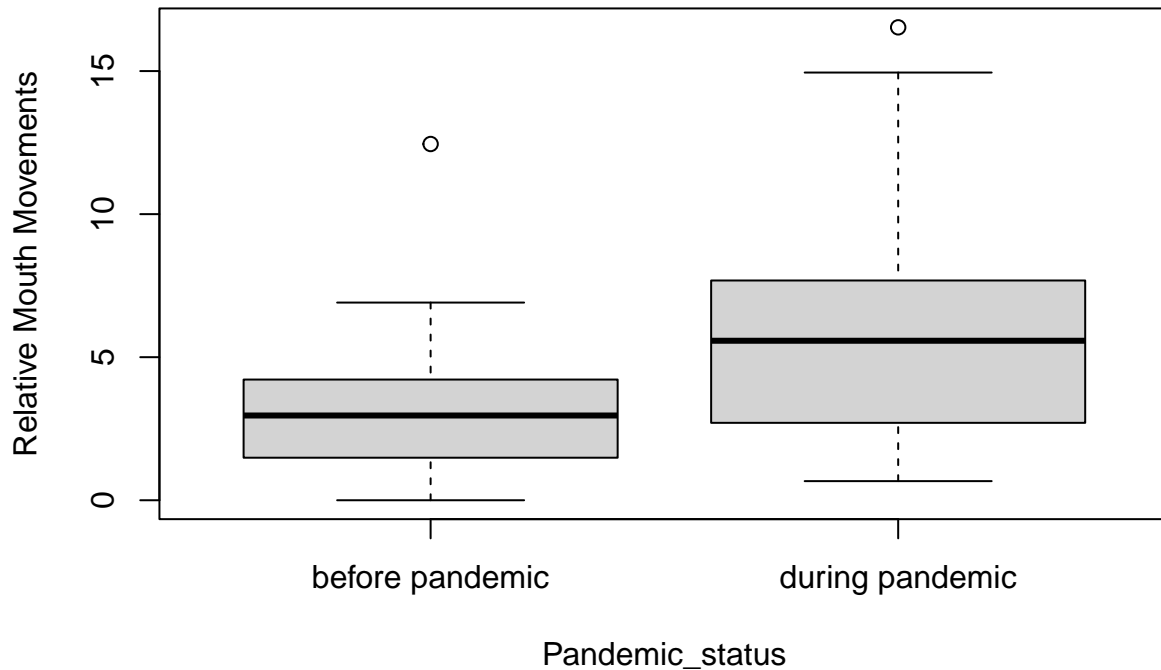
```
summary(fit.Headmove<-glmmTMB(
  TotalHeadmovements~
  Pandemic_status+
  fetus_gender+
  HADS_anxiety+HADS_depression+PSS_perceivedstress+Attachment+
  maternal_age +
  ## maternal_BMI +
  ## education +
  ## HC_20weeks_mm+
  gestational_age_atscan_days
  ,
  offset=log(Codable_lenght_HeadVisible), family=nbinom2(link="log"),
  data=covid1
))
```

```
## Family: nbinom2 ( log )
## Formula:
## TotalHeadmovements ~ Pandemic_status + fetus_gender + HADS_anxiety +
##   HADS_depression + PSS_perceivedstress + Attachment + maternal_age +
##   gestational_age_atscan_days
## Data: covid1
## Offset: log(Codable_lenght_HeadVisible)
##
##      AIC      BIC   logLik deviance df.resid
##    287.9    304.7  -133.9   267.9      30
##
##
## Dispersion parameter for nbinom2 family (): 2.53
##
## Conditional model:
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    14.712014   7.291653   2.018  0.0436 *
## Pandemic_statusduring pandemic  0.267350   0.240611   1.111  0.2665
## fetus_gendermale    -0.200258   0.234595  -0.854  0.3933
## HADS_anxiety       -0.015719   0.073831  -0.213  0.8314
## HADS_depression     0.026788   0.077809   0.344  0.7306
## PSS_perceivedstress -0.033372   0.028890  -1.155  0.2480
## Attachment         -0.024947   0.022270  -1.120  0.2626
## maternal_age       -0.008229   0.023337  -0.353  0.7244
## gestational_age_atscan_days -0.072942   0.030234  -2.413  0.0158 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## Mouth movements

Boxplot of total mouth movements (including parting) per codable scan time (in minutes), before and during the pandemic:

```
boxplot(TotalMouthMovements/Codable_lenght_MouthVisible*60 ~
  Pandemic_status,
  ylab="Relative Mouth Movements", data=covid1)
```



T-test:

```
t.test(TotalMouthMovements/Codable_lenght_MouthVisible*60~ Pandemic_status, data=covid1)
```

```
##
## Welch Two Sample t-test
##
## data: TotalMouthMovements/Codable_lenght_MouthVisible * 60 by Pandemic_status
## t = -2.2912, df = 32.872, p-value = 0.0285
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -4.9095536 -0.2909272
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 3.308338 5.908578
```

Fitted model:

```
summary(fit.Mouthmove<-glmmTMB(
  TotalMouthMovements~
  Pandemic_status+
  fetus_gender+
  HADS_anxiety+ # remove for mediation analysis
  HADS_depression + PSS_perceivedstress + Attachment+
  maternal_age +
```

```

## maternal_BMI +
## education +
## HC_20weeks_mm+
gestational_age_atscan_days
,
offset=log(Codable_lenght_MouthVisible), family=nbinom2(link="log"),
data=covid1
))

```

```

## Family: nbinom2 ( log )
## Formula:
## TotalMouthMovements ~ Pandemic_status + fetus_gender + HADS_anxiety +
##   HADS_depression + PSS_perceivedstress + Attachment + maternal_age +
##   gestational_age_atscan_days
## Data: covid1
## Offset: log(Codable_lenght_MouthVisible)
##
##      AIC      BIC   logLik deviance df.resid
##  370.1   387.0  -175.1   350.1     30
##
##
## Dispersion parameter for nbinom2 family (): 2.02
##
## Conditional model:
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      6.123405   8.371255   0.732   0.4645
## Pandemic_statusduring pandemic  0.620618   0.258913   2.397   0.0165 *
## fetus_gendermale      -0.053770   0.239984  -0.224   0.8227
## HADS_anxiety          -0.016013   0.079880  -0.200   0.8411
## HADS_depression       0.064466   0.084288   0.765   0.4444
## PSS_perceivedstress  -0.001694   0.032116  -0.053   0.9579
## Attachment           0.003258   0.024052   0.136   0.8923
## maternal_age         0.008313   0.025166   0.330   0.7411
## gestational_age_atscan_days  -0.042949   0.034878  -1.231   0.2182
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

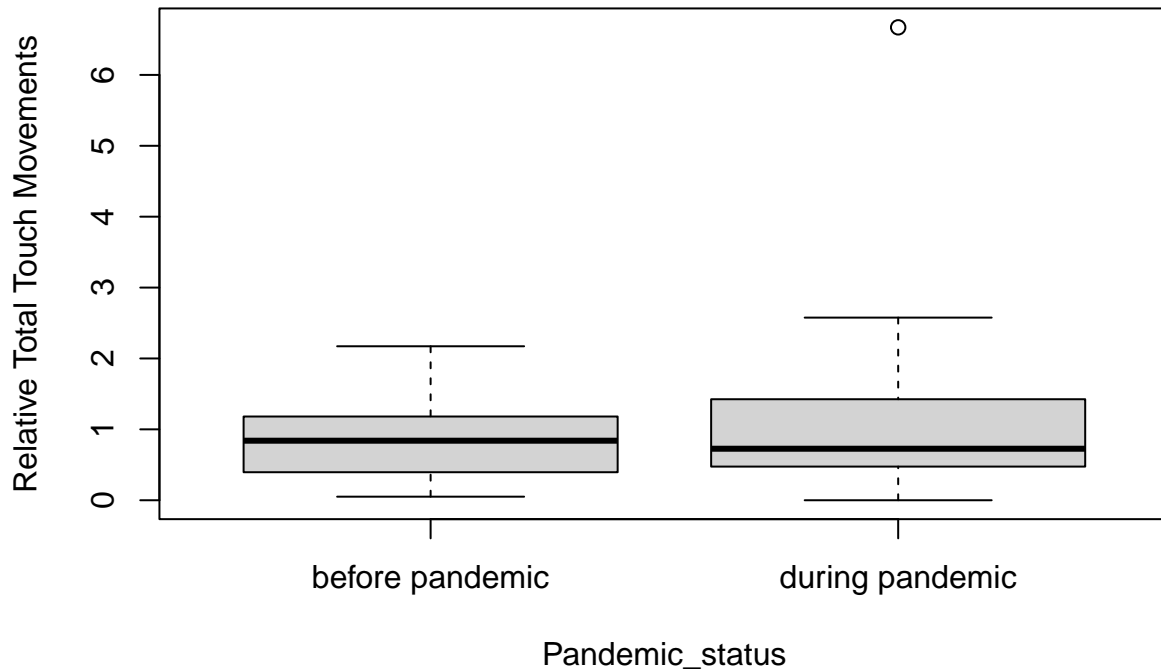
## Total Touches

Boxplot of the total number of touches per codable scan time (in minutes), before and during the pandemic:

```

boxplot(TotalTouchMovements/Codable_lenght_TouchVisible*60~ Pandemic_status,
        ylab="Relative Total Touch Movements", data=covid1)

```



T-test:

```
t.test(TotalTouchMovements/Codable_lenght_TouchVisible*60~ Pandemic_status, data=covid1)
```

```
##
## Welch Two Sample t-test
##
## data: TotalTouchMovements/Codable_lenght_TouchVisible * 60 by Pandemic_status
## t = -0.88795, df = 25.133, p-value = 0.383
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -1.052512 0.418243
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 0.895163 1.212298
```

There is no effect of the pandemic on the total number of touches ( $p=0.383$ ). Fitted models are not reported as they don't carry any significant effects.

```
summary(fit.TotalTouch<-glmmTMB(
  TotalTouchMovements~
  Pandemic_status+
  fetus_gender+
  HADS_anxiety+ # remove for mediation analysis
  HADS_depression+PSS_perceivedstress+Attachment+
```

```

maternal_age +
## maternal_BMI +
## education +
## HC_20weeks_mm+
gestational_age_atscan_days
,
offset=log(Codable_lenght_MouthVisible), family=nbinom2(link="log"),
data=covid1
)) #

```

```

## Family: nbinom2 ( log )
## Formula:
## TotalTouchMovements ~ Pandemic_status + fetus_gender + HADS_anxiety +
##   HADS_depression + PSS_perceivedstress + Attachment + maternal_age +
##   gestational_age_atscan_days
## Data: covid1
## Offset: log(Codable_lenght_MouthVisible)
##
##      AIC      BIC  logLik deviance df.resid
##    311.5    328.4  -145.8   291.5      30
##
##
## Dispersion parameter for nbinom2 family (): 1.31
##
## Conditional model:
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      1.030904   9.698075   0.106   0.9153
## Pandemic_statusduring pandemic  0.666922   0.309831   2.152   0.0314 *
## fetus_gendermale      -0.294458   0.304510  -0.967   0.3335
## HADS_anxiety          0.131277   0.102302   1.283   0.1994
## HADS_depression      -0.062251   0.101452  -0.614   0.5395
## PSS_perceivedstress  -0.054047   0.044929  -1.203   0.2290
## Attachment           0.035636   0.027704   1.286   0.1983
## maternal_age        -0.005775   0.031812  -0.182   0.8560
## gestational_age_atscan_days  -0.032311   0.039184  -0.825   0.4096
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

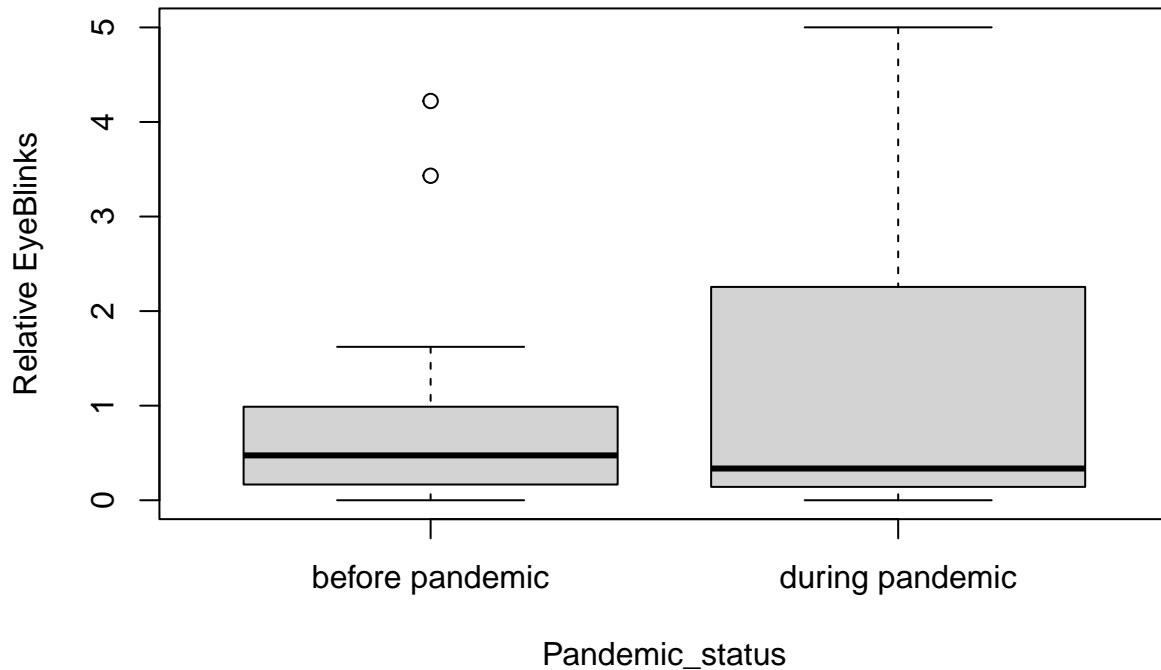
## Eyeblinks

Boxplot of eye blinks per codable scan time (in minutes), before and during the pandemic:

```

boxplot(Totalnumber_EyeBlink/Codable_lenght_EyeVisible*60~ Pandemic_status, ylab="Relative EyeBlinks", c

```



T-test:

```
t.test(Totalnumber_EyeBlink/Codable_lenght_EyeVisible*60~ Pandemic_status, data=covid1)
```

```
##
## Welch Two Sample t-test
##
## data: Totalnumber_EyeBlink/Codable_lenght_EyeVisible * 60 by Pandemic_status
## t = -0.84288, df = 34.136, p-value = 0.4052
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -1.250616 0.517269
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 0.8333992 1.2000725
```

There is no effect of the pandemic on the number of eye blinks ( $p=0.405$ ). Fitted models are not reported as they don't carry any significant effects.

```
summary(fit.Eye<-glmmTMB(
  Totalnumber_EyeBlink~
  Pandemic_status+
  fetus_gender+
  HADS_anxiety+
  HADS_depression+PSS_perceivedstress+Attachment+
```

```

maternal_age +
## maternal_BMI +
## education +
## HC_20weeks_mm+
gestational_age_atscan_days
,
offset=log(Codable_lenght_MouthVisible), family=nbinom2(link="log"),
data=covid1
)) #

```

```

## Family: nbinom2 ( log )
## Formula:
## Totalnumber_EyeBlink ~ Pandemic_status + fetus_gender + HADS_anxiety +
##   HADS_depression + PSS_perceivedstress + Attachment + maternal_age +
##   gestational_age_atscan_days
## Data: covid1
## Offset: log(Codable_lenght_MouthVisible)
##
##      AIC      BIC   logLik deviance df.resid
##    273.7    290.6   -126.9    253.7      30
##
##
## Dispersion parameter for nbinom2 family (): 0.651
##
## Conditional model:
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      9.907124  16.589214   0.597   0.5504
## Pandemic_statusduring pandemic  0.773716   0.447070   1.731   0.0835 .
## fetus_gendermale             -0.785700   0.443982  -1.770   0.0768 .
## HADS_anxiety                 -0.245316   0.165867  -1.479   0.1391
## HADS_depression              -0.004423   0.157272  -0.028   0.9776
## PSS_perceivedstress           0.106189   0.068262   1.556   0.1198
## Attachment                   -0.069335   0.043535  -1.593   0.1112
## maternal_age                 -0.028114   0.041911  -0.671   0.5023
## gestational_age_atscan_days  -0.033102   0.065670  -0.504   0.6142
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## All boxplots for movement types

```

#png("movement-boxplots.png", width=480, height=330)
par(mfrow=c(1,5))
boxplot(TotalMouthMovements/Codable_lenght_MouthVisible*60 ~
        pandemic_status, ylab="Relative Mouth Movements", data=covid1, col=c(2,4))

boxplot(TotalUpperFaceMovements/Codable_lenght_UpperFaceVisible*60 ~
        pandemic_status, ylab="Relative Upper Face Movements", data=covid1, col=c(2,4))

boxplot(TotalHeadmovements/Codable_lenght_HeadVisible*60 ~
        pandemic_status, ylab="Relative Total Head Movements", data=covid1, col=c(2,4))

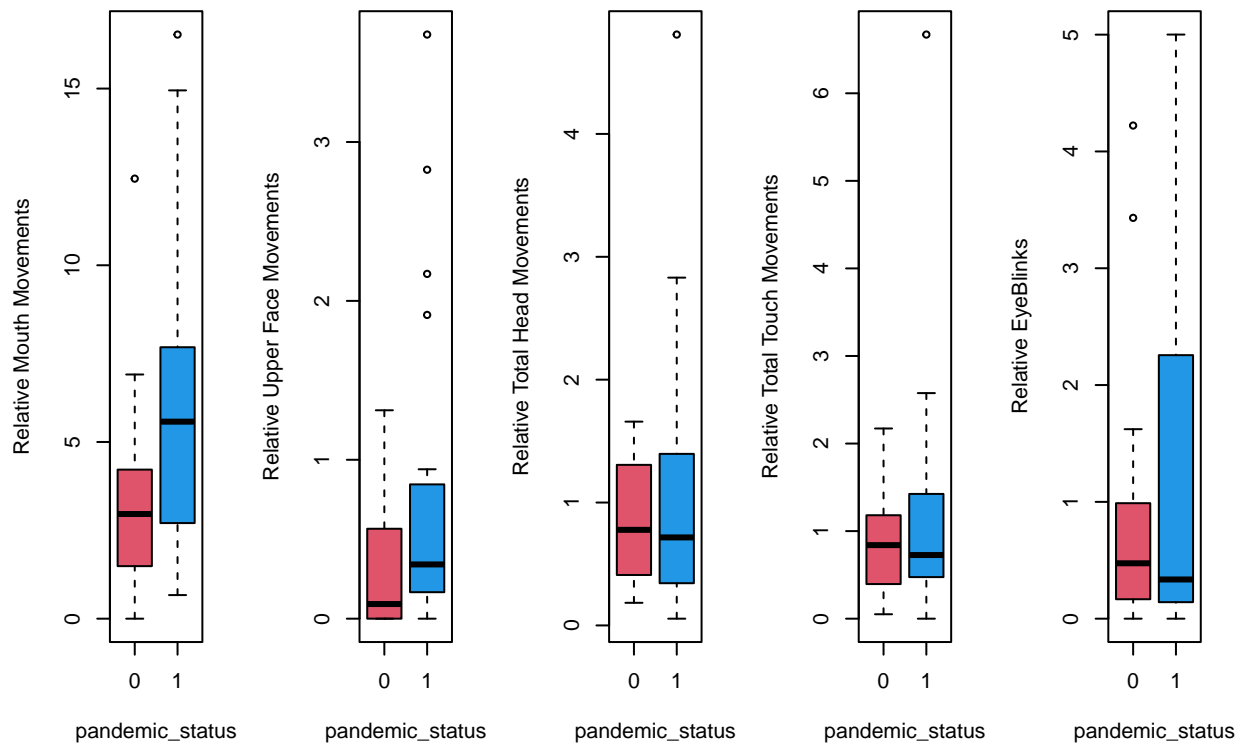
```

```

boxplot(TotalTouchMovements/Codable_lenght_TouchVisible*60~
        pandemic_status, ylab="Relative Total Touch Movements", data=covid1, col=c(2,4))

boxplot(Totalnumber_EyeBlink/Codable_lenght_EyeVisible*60~
        pandemic_status, ylab="Relative EyeBlinks", data=covid1, col=c(2,4))

```



```
#dev.off()
```

## Analyses of the mental health and attachment variables

Histograms:

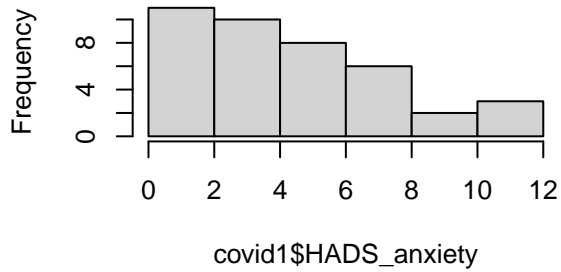
```

par(mfrow=c(2,2))
hist(covid1$HADS_anxiety)
hist(covid1$HADS_depression)
hist(covid1$PSS_perceivedstress)
hist(covid1$Attachment)

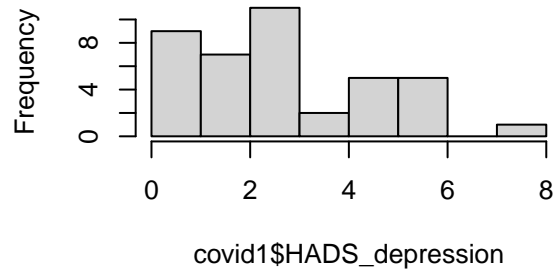
```



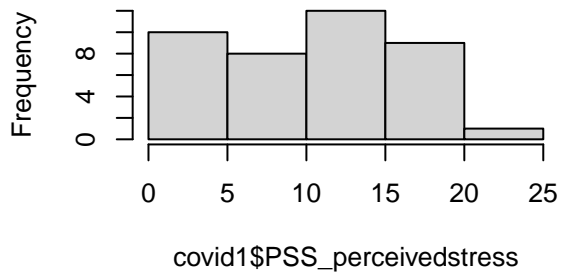
**Histogram of covid1\$HADS\_anxiety**



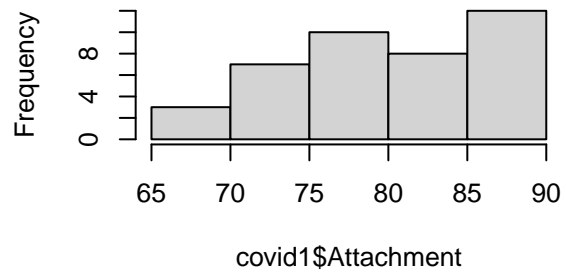
**Histogram of covid1\$HADS\_depression**



**Histogram of covid1\$PSS\_perceivedstress**



**Histogram of covid1\$Attachment**



```
cor(covid1[,6:9])
```

```
##           HADS_anxiety HADS_depression PSS_perceivedstress
## HADS_anxiety           1.0000000      0.61142939      0.72584725
## HADS_depression        0.6114294      1.00000000      0.37504018
## PSS_perceivedstress    0.7258473      0.37504018      1.00000000
## Attachment            -0.1596730     -0.01196158      0.06399071
##           Attachment
## HADS_anxiety          -0.15967298
## HADS_depression       -0.01196158
## PSS_perceivedstress   0.06399071
## Attachment            1.00000000
```

```
# pairs(covid1[,6:9])
```

T-tests of each of these variables versus pandemic status:

```
t.test(HADS_anxiety ~ Pandemic_status, data=covid1)
```

```
##
## Welch Two Sample t-test
##
## data:  HADS_anxiety by Pandemic_status
## t = -1.8942, df = 36.544, p-value = 0.06614
```

```
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -3.6227463 0.1227463
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 3.90 5.65
```

```
t.test(HADS_depression ~ Pandemic_status, data=covid1)
```

```
##
## Welch Two Sample t-test
##
## data: HADS_depression by Pandemic_status
## t = -1.4749, df = 37.285, p-value = 0.1486
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -2.1361046 0.3361046
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 2.65 3.55
```

```
t.test(PSS_perceivedstress ~ Pandemic_status, data=covid1)
```

```
##
## Welch Two Sample t-test
##
## data: PSS_perceivedstress by Pandemic_status
## t = -0.73819, df = 37.817, p-value = 0.465
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -5.239945 2.439945
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 10.1 11.5
```

```
t.test(Attachment ~ Pandemic_status, data=covid1)
```

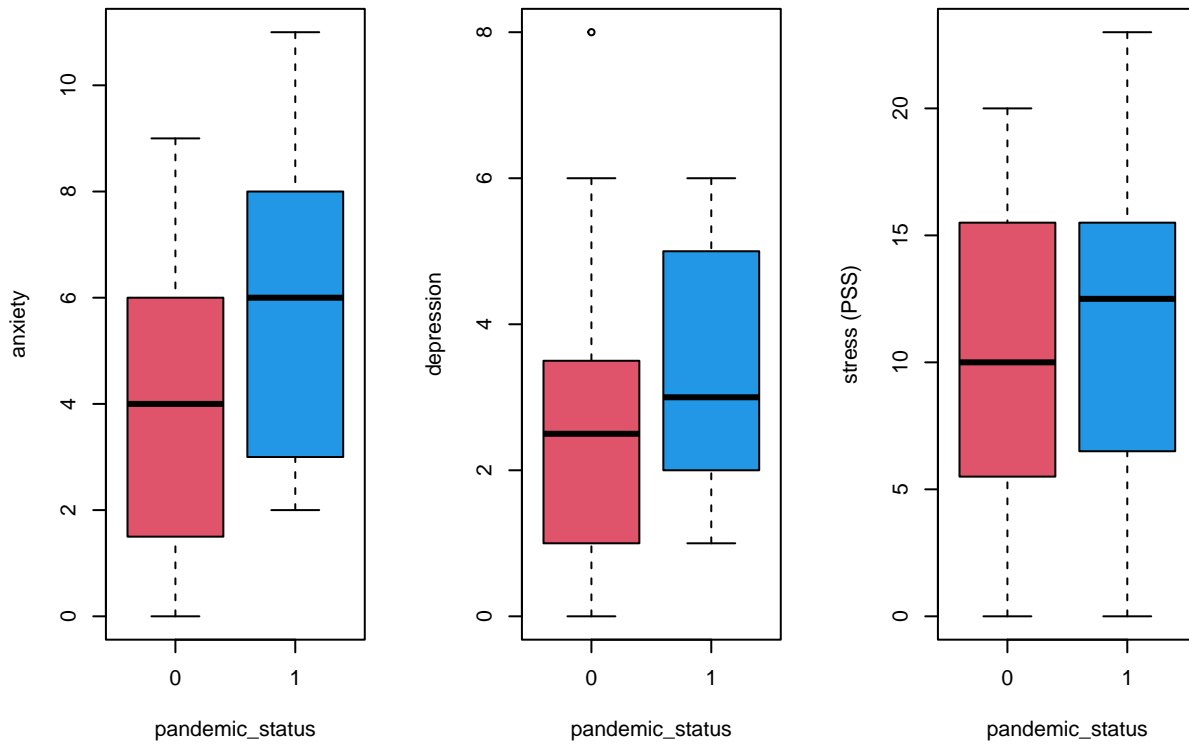
```
##
## Welch Two Sample t-test
##
## data: Attachment by Pandemic_status
## t = 1.1931, df = 37.945, p-value = 0.2402
## alternative hypothesis: true difference in means between group before pandemic and group during pandemic
## 95 percent confidence interval:
## -1.602762 6.202762
## sample estimates:
## mean in group before pandemic mean in group during pandemic
## 81.8 79.5
```

```
#png("mental-health-boxplots.png", width=480, height=330)
par(mfrow=c(1,3))
```

```
boxplot(HADS_anxiety ~  
  pandemic_status, ylab="anxiety", data=covid1, col=c(2,4))
```

```
boxplot(HADS_depression ~  
  pandemic_status, ylab="depression", data=covid1, col=c(2,4))
```

```
boxplot(PSS_perceivedstress ~  
  pandemic_status, ylab="stress (PSS)", data=covid1, col=c(2,4))
```



```
#dev.off()
```