
```
concordance=TRUE
```

```
## Warning: package 'dplyr' was built under R version 3.3.3
```

```
sum(nhanes$modvigmin==0)/nrow(nhanes)
```

```
## [1] 0.07841659
```

```
sum(nhanes$vigmin==0)/nrow(nhanes)
```

```
## [1] 0.8801602
```

```
sum(nhanes$lightmin==0)/nrow(nhanes)
```

```
## [1] 0
```

```
#no diff in modmin by day really except 7th
```

```
nhanes %>% group_by(rep) %>% summarise(m=mean(modvigmin), s=sd(modmin)/sqrt(length(modmin)))
```

```
## # A tibble: 7 3
```

```
##   rep      m      s
```

```
##   <int>    <dbl>    <dbl>
```

```
## 1     1 22.60066 0.3411052
```

```
## 2     2 23.01777 0.3518468
```

```
## 3     3 22.96771 0.3583861
```

```
## 4     4 22.41386 0.3488521
```

```
## 5     5 22.24356 0.3589189
```

```
## 6     6 21.15523 0.3571320
```

```
## 7     7 19.41996 0.3616865
```

```
#no diff in modmin by day really except 7th and 2nd
```

```
nhanes %>% group_by(rep) %>% summarise(m=mean(lightmin), s=sd(lightmin)/sqrt(length(lightmin)))
```

```

## # A tibble: 7  3
##       rep      m      s
##   <int>  <dbl>  <dbl>
## 1     1 258.6827 1.048918
## 2     2 261.5339 1.093391
## 3     3 258.6147 1.096388
## 4     4 258.8213 1.136550
## 5     5 258.2212 1.160056
## 6     6 255.2295 1.186014
## 7     7 244.4119 1.253172

#mondays most vig, fri-sun least, tues-thurs similar
nhanes %>% group_by(rep) %>% summarise(m=mean(vigmin),s=sd(vigmin)/sqrt(length(lightmin)))

## # A tibble: 7  3
##       rep      m      s
##   <int>  <dbl>  <dbl>
## 1     1 0.9411853 0.06110670
## 2     2 0.8115414 0.05276647
## 3     3 0.8965840 0.06021138
## 4     4 0.7660865 0.05689883
## 5     5 0.7392597 0.05397894
## 6     6 0.8310108 0.06361269
## 7     7 0.6902050 0.06106663

anova(lm(modvigmin~as.factor(rep),data=subset(nhanes,rep<6))) #first 5 days are similar, last 2 are different

## Analysis of Variance Table

## 

## Response: modvigmin

##           Df  Sum Sq Mean Sq F value Pr(>F)
## as.factor(rep)    4   2902   725.44  0.8288 0.5065

```

```
## Residuals      31937 27954416 875.30
```

#weekends lower

```
nhanes %>% group_by(dow) %>% summarise(m=mean(modvigmin), s=sd(modvigmin)/sqrt(length(modvigmin)))
```



```
## # A tibble: 7  3
##       dow     m     s
##   <int> <dbl> <dbl>
## 1     1 17.46672 0.3539009
## 2     2 23.63394 0.3753241
## 3     3 23.49455 0.3683897
## 4     4 23.63173 0.3842220
## 5     5 23.18340 0.3712310
## 6     6 22.43408 0.3639320
## 7     7 19.52794 0.3799264
```

#weekends and thursday lower, friday higher

```
nhanes %>% group_by(dow) %>% summarise(m=mean(lightmin), s=sd(lightmin)/sqrt(length(lightmin)))
```

A tibble: 7 3

```
##       dow     m     s
##   <int> <dbl> <dbl>
## 1     1 239.7397 1.171315
## 2     2 259.8399 1.106457
## 3     3 260.0095 1.095333
## 4     4 259.8370 1.102353
## 5     5 256.6507 1.103868
## 6     6 263.0100 1.146749
## 7     7 256.8055 1.218114
```

#first day vig

```
nhanes %>% group_by(dow) %>% summarise(m=mean(vigmin), s=sd(vigmin)/sqrt(length(vigmin)))
```

```

## # A tibble: 7 × 3
##       dow      m      s
##   <int>  <dbl>  <dbl>
## 1     1 0.7239862 0.06502960
## 2     2 0.9462687 0.06184397
## 3     3 0.8742129 0.05357820
## 4     4 0.8859250 0.06278267
## 5     5 0.8446359 0.05683506
## 6     6 0.7264334 0.05487292
## 7     7 0.6707994 0.05419137

anova(lm(modvigmin~as.factor(dow),data=subset(nhanes,dow%in%c(2:6)))) #M-F similar

## Analysis of Variance Table

## Response: modvigmin

##           Df  Sum Sq Mean Sq F value Pr(>F)
## as.factor(dow)  4    6363  1590.75  1.7992 0.1259
## Residuals     31803 28118692   884.15

#test for weekend effects

anova(lm(modvigmin ~ as.factor(weekend),data=nhanes))

## Analysis of Variance Table

## Response: modvigmin

##           Df  Sum Sq Mean Sq F value    Pr(>F)
## as.factor(weekend)  1  181096  181096  214.83 < 2.2e-16 ***
## Residuals         42438 35773439      843
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

anova(lm(lightmin ~ as.factor(weekend),data=nhanes))

## Analysis of Variance Table
##
## Response: lightmin
##                               Df   Sum Sq Mean Sq F value    Pr(>F)
## as.factor(weekend)      1 1042016 1042016 133.48 < 2.2e-16 ***
## Residuals                 42438 331295573     7807
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```



```

anova(lm(vigmin ~ as.factor(weekend),data=nhanes))

## Analysis of Variance Table
##
## Response: vigmin
##                               Df   Sum Sq Mean Sq F value    Pr(>F)
## as.factor(weekend)      1    202 202.477   9.714 0.00183 **
## Residuals                 42438 884572   20.844
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

nrep <- (nhanes %>% group_by(id) %>% summarise(n=length(id)))$n

#m1 <- lme(modvigmin~1,data=nhanes,random=~1|id,correlation=corAR1(form=~1/id),method="ML")
m1 <- lme(modvigmin~as.factor(rep)+as.factor(dow),data=nhanes,random=~1|id,method="ML")

re <- rep(unlist(ranef(m1)),nrep)
nhanes$error <- nhanes$modvigmin - predict(m1)
eht <- nhanes %>% group_by(id) %>% summarise(e1=error[1],e2=error[2],e3=error[3],e4=error[4],e5=error[5])

```

```

# ind <- which(!is.na(eht$e7))

# boxtest <- rep(0,length(ind))

# for(i in 1:length(ind)){
#   boxtest[i] <- Box.test(unlist(eht[ind[i],-1]),lag=2,type="Ljung-Box")$p.value
# }

# summary(boxtest)

#lag 1 difference

o1a = c(eht$e1[nrep > 1],eht$e2[nrep > 2],eht$e3[nrep > 3],eht$e4[nrep > 4],eht$e5[nrep > 5],eht$e6[nrep > 6],eht$e7[nrep > 7])
o1b = c(eht$e2[nrep > 1],eht$e3[nrep > 2],eht$e4[nrep > 3],eht$e5[nrep > 4],eht$e6[nrep > 5],eht$e7[nrep > 6])
cor(o1a,o1b)

## [1] -0.1000537

#lag 2 diff

o2a = c(eht$e1[nrep > 2],eht$e2[nrep > 3],eht$e3[nrep > 4],eht$e4[nrep > 5],eht$e5[nrep > 6],eht$e6[nrep > 7])
o2b = c(eht$e3[nrep > 2],eht$e4[nrep > 3],eht$e5[nrep > 4],eht$e6[nrep > 5],eht$e7[nrep > 6])
cor(o2a,o2b)

## [1] -0.1892647

#lag 3 diff

o3a = c(eht$e1[nrep > 3],eht$e2[nrep > 4],eht$e3[nrep > 5],eht$e4[nrep > 6],eht$e5[nrep > 7])
o3b = c(eht$e4[nrep > 3],eht$e5[nrep > 4],eht$e6[nrep > 5],eht$e7[nrep > 6])
cor(o3a,o3b)

## [1] -0.2558842

#lag 4 diff

o4a = c(eht$e1[nrep > 4],eht$e2[nrep > 5],eht$e3[nrep > 6])
o4b = c(eht$e5[nrep > 4],eht$e6[nrep > 5],eht$e7[nrep > 6])
cor(o4a,o4b)

```

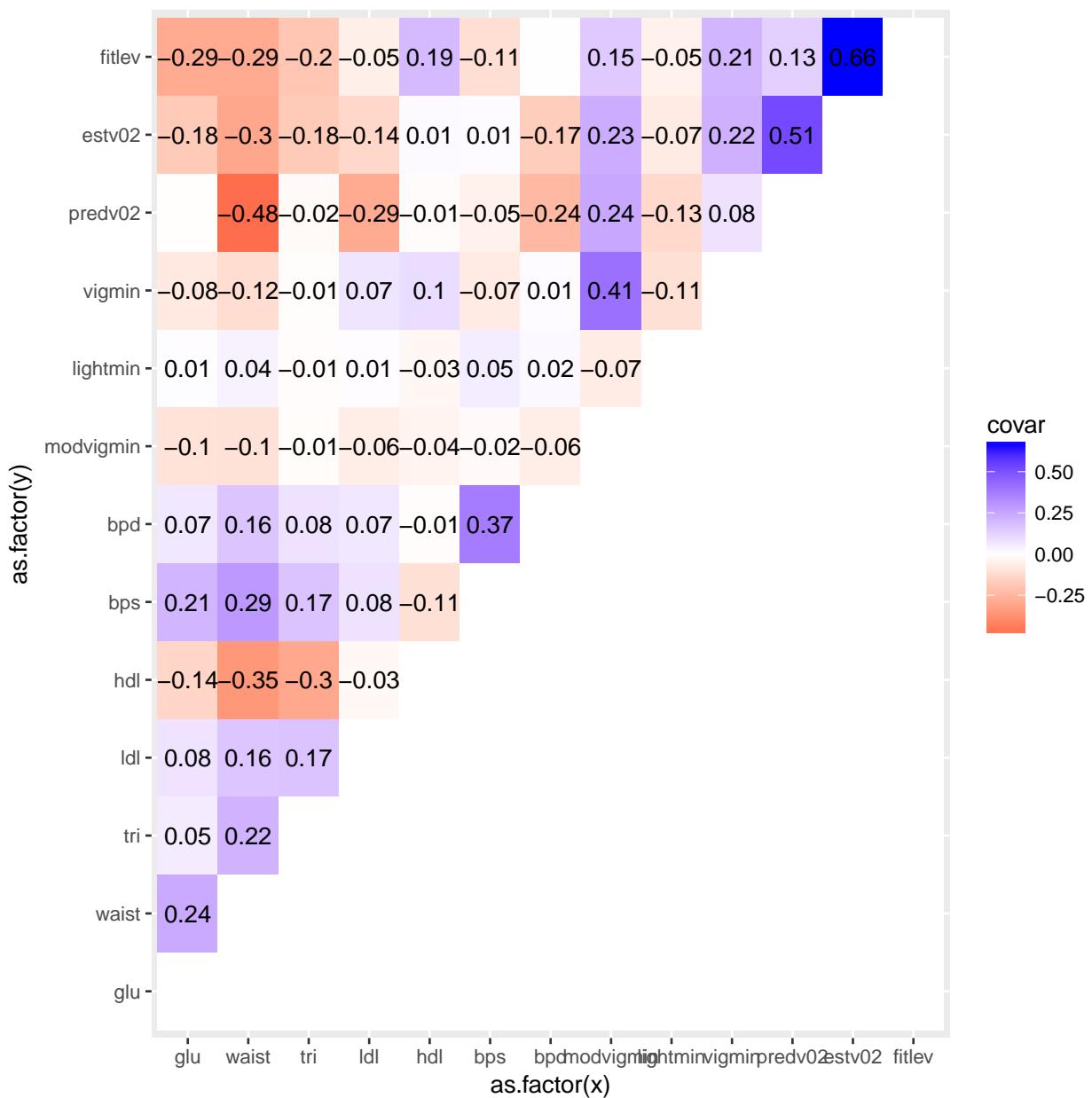
```

## [1] -0.2653008

#lag 5 diff
o5a = c(eht$e1[nrep > 5], eht$e2[nrep > 6])
o5b = c(eht$e6[nrep > 5], eht$e7[nrep > 6])
cor(o5a,o5b)

## [1] -0.1862721

```



```
#multivariate regression on mean observed modvig, light

a <- nhanes %>% group_by(id) %>% summarise(modvig=mean(modvigmin),light=mean(lightmin))

y$modvig <- a$modvig
y$light <- a$light

m3 <- lm(with(y,cbind(glu,waist,tri,hdl,bps,bpd))~y$modvig)
summary(m3)

## Response glu :

##
## Call:
## lm(formula = glu ~ y$modvig)
##
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -62.50 -14.31  -6.71   2.63  440.78 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 107.87227   0.74640 144.524 <2e-16 ***
## y$modvig     -0.18519   0.02181  -8.491 <2e-16 ***
## ---      
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 32.92 on 3574 degrees of freedom
## (4668 observations deleted due to missingness)
## Multiple R-squared:  0.01977, Adjusted R-squared:  0.0195 
## F-statistic:  72.1 on 1 and 3574 DF,  p-value: < 2.2e-16
##
## Response waist :
```

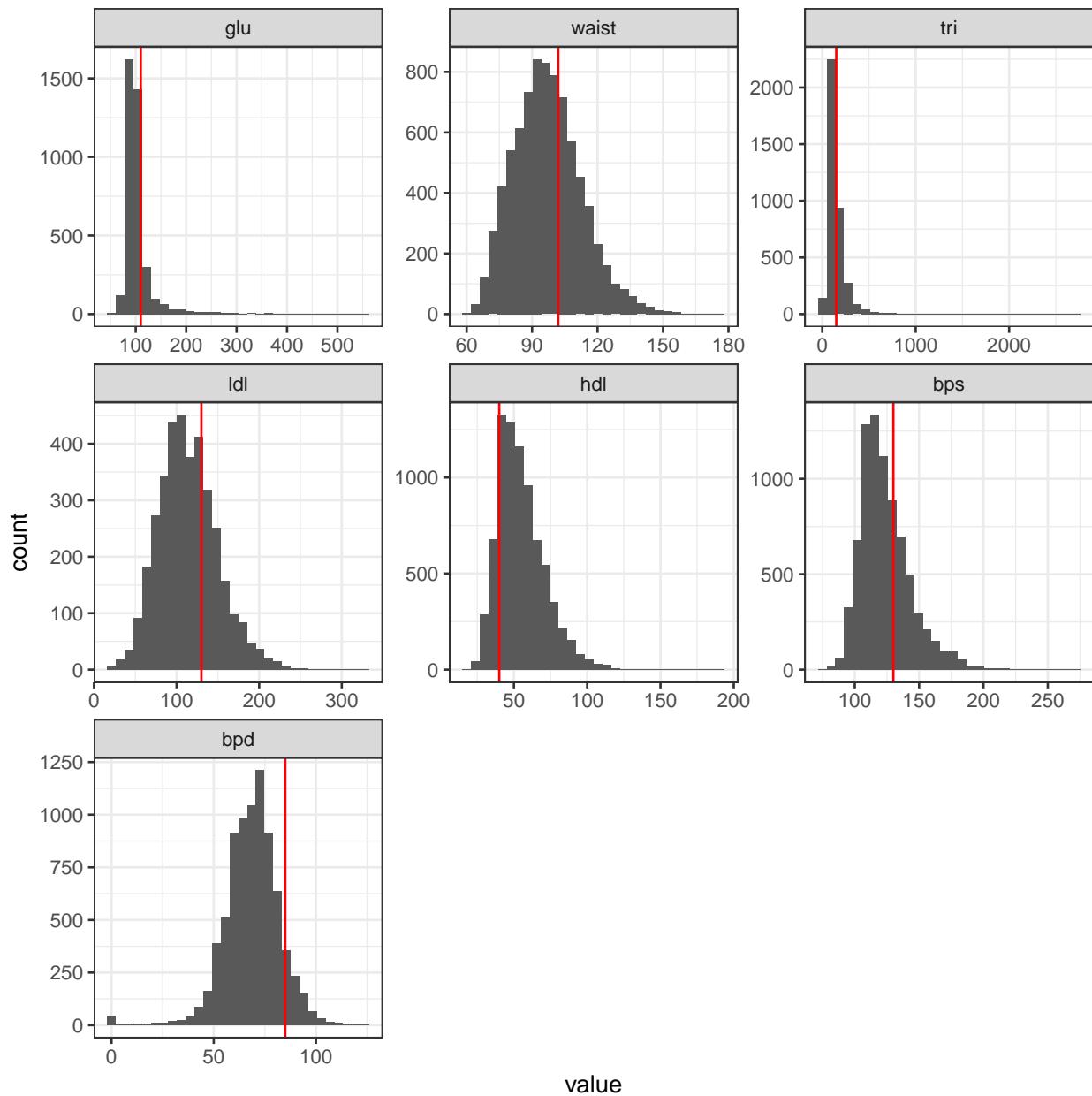
```
##  
## Call:  
## lm(formula = waist ~ y$modvig)  
##  
## Residuals:  
##       Min     1Q Median     3Q    Max  
## -37.507 -10.795 -1.156  9.475 58.162  
##  
## Coefficients:  
##              Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 100.19115    0.34288 292.20 <2e-16 ***  
## y$modvig     -0.12379    0.01002 -12.36 <2e-16 ***  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1  
##  
## Residual standard error: 15.12 on 3574 degrees of freedom  
## (4668 observations deleted due to missingness)  
## Multiple R-squared:  0.04096, Adjusted R-squared:  0.0407  
## F-statistic: 152.7 on 1 and 3574 DF,  p-value: < 2.2e-16  
##  
##  
## Response tri :  
##  
## Call:  
## lm(formula = tri ~ y$modvig)  
##  
## Residuals:  
##       Min     1Q Median     3Q    Max  
## -121.18 -65.00 -30.59  27.40 2585.85  
##  
## Coefficients:
```

```
##           Estimate Std. Error t value Pr(>|t|) 
## (Intercept) 154.32305   2.85134  54.123 < 2e-16 ***
## y$modvig    -0.40685   0.08331 -4.883 1.09e-06 ***
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 125.7 on 3574 degrees of freedom
## (4668 observations deleted due to missingness)
## Multiple R-squared:  0.006628, Adjusted R-squared:  0.00635 
## F-statistic: 23.85 on 1 and 3574 DF,  p-value: 1.089e-06
## 
## Response hdl : 
## 
## Call:
## lm(formula = hdl ~ y$modvig)
## 
## Residuals:
##      Min       1Q     Median       3Q      Max 
## -38.675 -11.922  -2.698   9.320 132.359
## 
## Coefficients:
##           Estimate Std. Error t value Pr(>|t|) 
## (Intercept) 55.6949   0.3695 150.740 <2e-16 ***
## y$modvig   -0.0233   0.0108 -2.158   0.031 *  
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 16.29 on 3574 degrees of freedom
## (4668 observations deleted due to missingness)
## Multiple R-squared:  0.001302, Adjusted R-squared:  0.001022
```

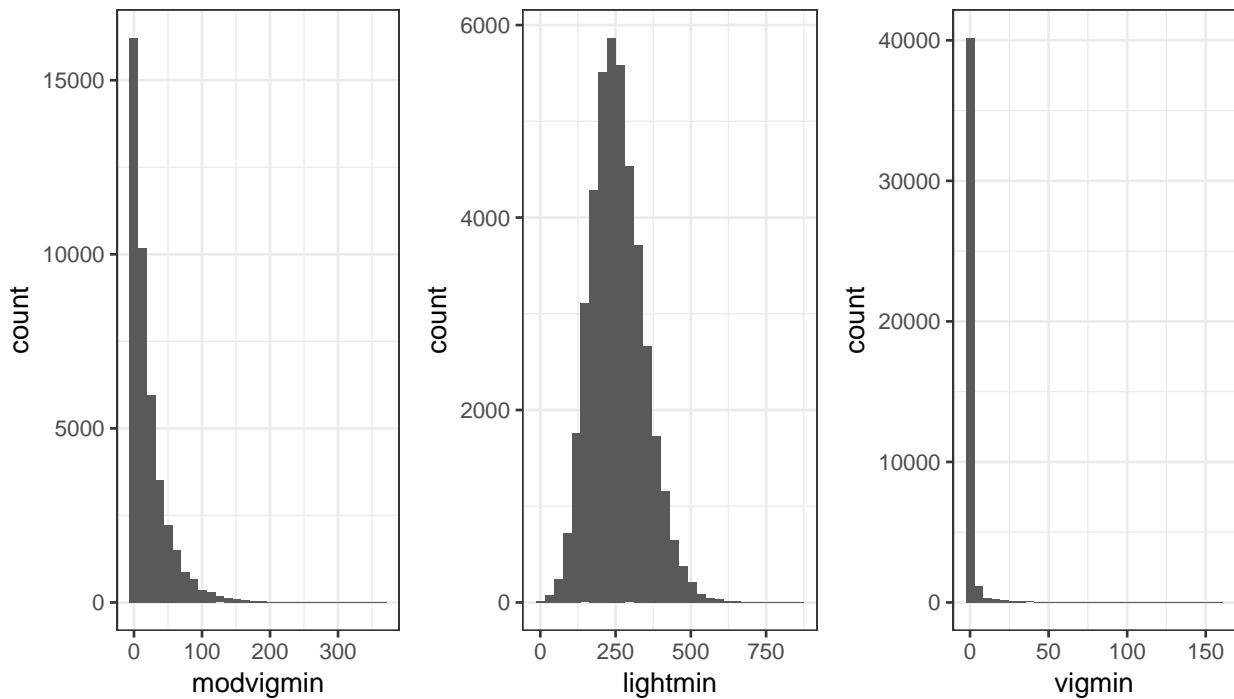
```
## F-statistic: 4.658 on 1 and 3574 DF, p-value: 0.03097
##
##
## Response bps :
##
## Call:
## lm(formula = bps ~ y$modvig)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -44.510 -13.122  -2.921  10.172  93.694
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 126.33975  0.43377 291.26 <2e-16 ***
## y$modvig    -0.13340  0.01267 -10.53 <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 19.13 on 3574 degrees of freedom
## (4668 observations deleted due to missingness)
## Multiple R-squared:  0.03006, Adjusted R-squared:  0.02979
## F-statistic: 110.8 on 1 and 3574 DF, p-value: < 2.2e-16
##
##
## Response bpd :
##
## Call:
## lm(formula = bpd ~ y$modvig)
##
## Residuals:
```

```
##      Min       1Q     Median       3Q      Max
## -68.064 -7.423    0.529    8.164   47.533
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 67.729506   0.310267 218.294 <2e-16 ***
## y$modvig    0.013836   0.009066   1.526    0.127
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.68 on 3574 degrees of freedom
## (4668 observations deleted due to missingness)
## Multiple R-squared:  0.0006513, Adjusted R-squared:  0.0003717
## F-statistic: 2.329 on 1 and 3574 DF,  p-value: 0.1271
```

```
## Using as id variables
## 'stat_bin()' using 'bins = 30'. Pick better value with 'binwidth'.
## Warning: Removed 14799 rows containing non-finite values (stat_bin).
```



```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



```

summary(lm(wearmin~as.factor(dow),data=nhanes))

##
## Call:
## lm(formula = wearmin ~ as.factor(dow), data = nhanes)
##
## Residuals:
##    Min     1Q   Median     3Q    Max 
## -261.67 -108.24  -10.55   86.38  621.12 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 818.882    2.048 399.784 < 2e-16 ***
## as.factor(dow)2 36.599    2.764 13.240 < 2e-16 ***
## as.factor(dow)3 39.281    2.750 14.282 < 2e-16 ***
## as.factor(dow)4 40.428    2.764 14.629 < 2e-16 ***
## as.factor(dow)5 34.328    2.762 12.427 < 2e-16 ***
## as.factor(dow)6 42.792    2.784 15.373 < 2e-16 ***

```

```
## as.factor(dow) 7 21.738      2.873    7.566 3.92e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 148.1 on 42433 degrees of freedom
## Multiple R-squared:  0.008106, Adjusted R-squared:  0.007965
## F-statistic: 57.79 on 6 and 42433 DF,  p-value: < 2.2e-16

summary(lm(wearmin~as.factor(rep),data=nhanes))

##
## Call:
## lm(formula = wearmin ~ as.factor(rep), data = nhanes)
##
## Residuals:
##       Min     1Q   Median     3Q    Max 
## -258.59 -109.09  -11.53   87.27  615.71 
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) 850.727    1.822 466.907 < 2e-16 ***
## as.factor(rep)2 7.868    2.581  3.048 0.00231 ** 
## as.factor(rep)3 5.366    2.599  2.065 0.03893 *  
## as.factor(rep)4 5.782    2.614  2.212 0.02700 *  
## as.factor(rep)5 2.224    2.638  0.843 0.39906    
## as.factor(rep)6 -2.202    2.684 -0.820 0.41198    
## as.factor(rep)7 -26.440    2.807 -9.420 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 148.4 on 42433 degrees of freedom
```

```
## Multiple R-squared:  0.004513, Adjusted R-squared:  0.004372
## F-statistic: 32.06 on 6 and 42433 DF,  p-value: < 2.2e-16






```

```
##      1     2     3     4     5     6     7
## 1 1507 1482 1180  547  586  543  786
## 2  722 1700 1458 1124  512  567  502
## 3  451  797 1687 1378 1102  480  516
## 4  473  503  789 1638 1368 1062  430
## 5  398  529  486  776 1624 1294  945
## 6  830  472  513  465  764 1545 1080
## 7  847  882  398  445  429  683 1145

dim(nhanes)

## [1] 42440     39

length(unique(nhanes$id))

## [1] 8244


```

```

#no big changes by taking one of the 7 metsynd variables out

id7complete <- unique(meas7$id[complete.cases(meas7[,c("smplwt","sex","age","race","rep","dow","wearn"),na.rm=TRUE)],na.rm=TRUE)

meas67 <- subset(nhanes, id %in% unique(id)[nrep>=6] & rep <= 6) #individuals with 6 days
length(unique(meas67$id[complete.cases(meas67[,c("smplwt","sex","age","race","rep","dow","wearn"),na.rm=TRUE)],na.rm=TRUE))

## [1] 1878

meas57 <- subset(nhanes, id %in% unique(id)[nrep>=5] & rep <= 5) #individuals with 6 days
length(unique(meas57$id[complete.cases(meas57[,c("smplwt","sex","age","race","rep","dow","wearn"),na.rm=TRUE)],na.rm=TRUE))

## [1] 2424

id57complete <- unique(meas57$id[complete.cases(meas57[,c("smplwt","sex","age","race","rep","dow","wearn"),na.rm=TRUE)],na.rm=TRUE)

table((meas57 %>% group_by(id) %>% summarise(n=length(id)))$n)

## 
##      3      4      5
##    333 1510 3846

table((meas67 %>% group_by(id) %>% summarise(n=length(id)))$n)

## 
##      5      6
##    1088 3352

q1 <- lm(modvigmin~as.factor(rep),data=nhanes)
nhanes$rep2 <- nhanes$rep
nhanes$rep2[nhanes$rep %in% c(1:5)] <- 1
q2 <- lm(modvigmin~as.factor(rep2),data=nhanes)

```

```
anova(q1,q2)

## Analysis of Variance Table
##
## Model 1: modvigmin ~ as.factor(rep)
## Model 2: modvigmin ~ as.factor(rep2)
##   Res.Df      RSS Df Sum of Sq      F Pr(>F)
## 1 42433 35902020
## 2 42437 35904922 -4    -2901.8 0.8574 0.4887

q3 <- lm(modvigmin~as.factor(dow),data=nhanes)
q4 <- lm(modvigmin~as.factor(weekend),data=nhanes)
nhanes$dow2 <- nhanes$dow
nhanes$dow2[nhanes$dow %in% c(2:6)] <- 2
q5 <- lm(modvigmin~as.factor(dow2),data=nhanes)

anova(q3,q4)

## Analysis of Variance Table
##
## Model 1: modvigmin ~ as.factor(dow)
## Model 2: modvigmin ~ as.factor(weekend)
##   Res.Df      RSS Df Sum of Sq      F     Pr(>F)
## 1 42433 35755786
## 2 42438 35773439 -5    -17653 4.1899 0.0008297 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

anova(q3,q5)

## Analysis of Variance Table
##
```

```
## Model 1: modvigmin ~ as.factor(dow)
## Model 2: modvigmin ~ as.factor(dow2)
##   Res.Df      RSS Df Sum of Sq      F Pr(>F)
## 1  42433 35755786
## 2  42437 35762149 -4     -6363 1.8878 0.1095

q1 <- lm(modvigmin~as.factor(rep),data=meas7)
meas7$rep2 <- meas7$rep
meas7$rep2[meas7$rep %in% c(1:5)] <- 1
q2 <- lm(modvigmin~as.factor(rep2),data=meas7)
anova(q1,q2)

## Analysis of Variance Table
##
## Model 1: modvigmin ~ as.factor(rep)
## Model 2: modvigmin ~ as.factor(rep2)
##   Res.Df      RSS Df Sum of Sq      F Pr(>F)
## 1  18410 14037352
## 2  18414 14038137 -4    -785.07 0.2574 0.9053

q3 <- lm(modvigmin~as.factor(dow),data=meas7)
q4 <- lm(modvigmin~as.factor(weekend),data=meas7)
meas7$dow2 <- meas7$dow
meas7$dow2[meas7$dow %in% c(2:6)] <- 2
q5 <- lm(modvigmin~as.factor(dow2),data=meas7)

anova(q3,q4)

## Analysis of Variance Table
##
## Model 1: modvigmin ~ as.factor(dow)
## Model 2: modvigmin ~ as.factor(weekend)
```

```

##   Res.Df      RSS Df Sum of Sq      F Pr(>F)
## 1 18410 13976558
## 2 18415 13983155 -5    -6597.3 1.738 0.1221

anova(q3,q5)

## Analysis of Variance Table

##
## Model 1: modvigmin ~ as.factor(dow)
## Model 2: modvigmin ~ as.factor(dow2)

##   Res.Df      RSS Df Sum of Sq      F Pr(>F)
## 1 18410 13976558
## 2 18414 13977073 -4    -515.62 0.1698 0.9539

m1a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corCompSymm(form=~1|id))
m2a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corAR1(form=~1|id),meas7)
m3a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corARMA(form=~1|id,p=1))
m4a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corARMA(form=~1|id,p=2))
m6a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corARMA(form=~1|id,p=3))
m7a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corSymm(form=~1|id),meas7)
m8a <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas7,correlation=corSymm(form=~1|id),meas7)

extractAIC(m1a)

## [1] 15.0 164398.1

extractAIC(m2a)

## [1] 15.0 166262.7

extractAIC(m3a)

## [1] 16.0 164252.2

```

```
extractAIC(m4a)

## [1] 16.0 164938.2

extractAIC(m6a)

## [1] 17.0 164181.5

extractAIC(m7a)

## [1] 35.0 164043.4

extractAIC(m8a)

## [1] 41.0 164029.9

anova(m3a,m2a)

##      Model df     AIC     BIC   logLik   Test  L.Ratio p-value
## m3a     1 16 164252.2 164377.3 -82110.08
## m2a     2 15 166262.8 166380.1 -83116.37 1 vs 2 2012.582 <.0001

anova(m6a,m3a)

##      Model df     AIC     BIC   logLik   Test  L.Ratio p-value
## m6a     1 17 164181.5 164314.4 -82073.73
## m3a     2 16 164252.2 164377.3 -82110.08 1 vs 2 72.71033 <.0001

anova(m7a,m6a)

##      Model df     AIC     BIC   logLik   Test  L.Ratio p-value
## m7a     1 35 164043.4 164317.1 -81986.68
## m6a     2 17 164181.5 164314.4 -82073.73 1 vs 2 174.0954 <.0001
```

```

anova(m8a,m7a)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m8a     1 41 164029.9 164350.5 -81973.94
## m7a     2 35 164043.4 164317.1 -81986.68 1 vs 2 25.47542  3e-04

meas57sub <- subset(meas57,rep <=5)

m1b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57sub,correlation=corCompSymm(form=~1|id))
m2b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57sub,correlation=corAR1(form=~1|id))
m3b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57sub,correlation=corARMA(form=~1|id))
m4b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57sub,correlation=corARMA(form=~1|id))
m6b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57sub,correlation=corARMA(form=~1|id))
m7b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57sub,correlation=corSymm(form=~1|id))
m8b <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas57,correlation=corSymm(form=~1|id))

extractAIC(m1b)

## [1] 13 238400

extractAIC(m2b)

## [1] 13.0 240187.2

extractAIC(m3b)

## [1] 14.0 238171.1

extractAIC(m4b)

## [1] 14.0 238567.7

extractAIC(m6b)

```

```
## [1] 15 238171

extractAIC(m7b)

## [1] 22.0 238067.3

extractAIC(m8b)

## [1] 26.0 238041.9

anova(m3b,m2b)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m3b     1 14 238171.1 238285.6 -119071.6
## m2b     2 13 240187.2 240293.5 -120080.6 1 vs 2 2018.088 <.0001

anova(m6b,m3b)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m6b     1 15 238171.0 238293.7 -119070.5
## m3b     2 14 238171.1 238285.6 -119071.6 1 vs 2 2.070635 0.1502

anova(m7b,m3b)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m7b     1 22 238067.3 238247.2 -119011.6
## m3b     2 14 238171.1 238285.6 -119071.6 1 vs 2 119.8111 <.0001

anova(m8b,m7b)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m8b     1 26 238041.9 238254.4 -118994.9
## m7b     2 22 238067.3 238247.2 -119011.6 1 vs 2 33.45403 <.0001
```

```
meas67sub <- subset(meas67,rep <=6)

m1c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corCompSymm(form=~1|id))
m2c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corAR1(form=~1|id))
m3c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corARMA(form=~1|id))
m4c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corARMA(form=~1|id))
m6c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corARMA(form=~1|id))
m7c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corSymm(form=~1|id))
m8c <- gls(modvigmin~as.factor(dow)+as.factor(rep),data=meas67sub,correlation=corSymm(form=~1|id))

extractAIC(m1c)

## [1] 14.0 230404.8

extractAIC(m2c)

## [1] 14.0 232528.5

extractAIC(m3c)

## [1] 15 230100

extractAIC(m4c)

## [1] 15.0 230692.3

extractAIC(m6c)

## [1] 16.0 230093.7

extractAIC(m7c)

## [1] 28.0 229972.9
```

```

extractAIC(m8c)

## [1] 33.0 229956.5

anova(m3c,m2c)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m3c     1 15 230100.0 230222.2 -115035.0
## m2c     2 14 232528.5 232642.6 -116250.2 1 vs 2 2430.536 <.0001

anova(m6c,m3c)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m6c     1 16 230093.7 230224.0 -115030.8
## m3c     2 15 230100.0 230222.2 -115035.0 1 vs 2 8.293493 0.004

anova(m7c,m6c)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m7c     1 28 229972.9 230201 -114958.4
## m6c     2 16 230093.7 230224 -115030.8 1 vs 2 144.7848 <.0001

anova(m7c,m8c)

##      Model df     AIC     BIC   logLik   Test L.Ratio p-value
## m7c     1 28 229972.9 230201.0 -114958.4
## m8c     2 33 229956.5 230225.4 -114945.3 1 vs 2 26.35735 1e-04

```

```

lme1 <- lme(modvigmin~as.factor(dow)+as.factor(rep),random=~1|id,data=meas7,correlation=corSymm)

```

```

summary(m8a) #gls without random effects

## Generalized least squares fit by maximum likelihood
## Model: modvigmin ~ as.factor(dow) + as.factor(rep)
## Data: meas7
##          AIC      BIC      logLik
## 164029.9 164350.5 -81973.94
##
## Correlation Structure: General
## Formula: ~1 | id
## Parameter estimate(s):
## Correlation:
##   1     2     3     4     5     6
## 2 0.600
## 3 0.583 0.651
## 4 0.523 0.578 0.658
## 5 0.550 0.608 0.661 0.682
## 6 0.561 0.536 0.603 0.600 0.634
## 7 0.558 0.539 0.557 0.517 0.554 0.586
## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | rep
## Parameter estimates:
##   1     2     3     4     5     6     7
## 1.0000000 0.9823352 1.0260409 1.0028533 1.0260458 0.9976716 0.9599137
##
## Coefficients:
##             Value Std.Error t-value p-value
## (Intercept) 17.195103 0.6072096 28.318233 0.0000
## as.factor(dow)2 5.415249 0.4702770 11.515019 0.0000
## as.factor(dow)3 5.052452 0.4976650 10.152314 0.0000

```

```

## as.factor(dow)4 4.876995 0.5138790 9.490551 0.0000
## as.factor(dow)5 4.907845 0.5136416 9.554999 0.0000
## as.factor(dow)6 4.647601 0.4972114 9.347334 0.0000
## as.factor(dow)7 2.268762 0.4728772 4.797782 0.0000
## as.factor(rep)2 -0.539641 0.4805194 -1.123037 0.2614
## as.factor(rep)3 -0.308111 0.5049796 -0.610145 0.5418
## as.factor(rep)4 -0.384855 0.5367814 -0.716967 0.4734
## as.factor(rep)5 -0.081066 0.5277860 -0.153596 0.8779
## as.factor(rep)6 -0.831819 0.5105435 -1.629282 0.1033
## as.factor(rep)7 -1.590955 0.4992559 -3.186652 0.0014
##
## Correlation:
##           (Intr) as.fctr(d)2 as.fctr(d)3 as.fctr(d)4 as.fctr(d)5
## as.factor(dow)2 -0.363
## as.factor(dow)3 -0.376  0.537
## as.factor(dow)4 -0.355  0.500    0.585
## as.factor(dow)5 -0.358  0.471    0.533    0.601
## as.factor(dow)6 -0.337  0.435    0.475    0.529    0.581
## as.factor(dow)7 -0.342  0.442    0.439    0.467    0.505
## as.factor(rep)2 -0.365 -0.095   -0.075   -0.105   -0.054
## as.factor(rep)3 -0.314 -0.074   -0.141   -0.153   -0.135
## as.factor(rep)4 -0.368 -0.030   -0.080   -0.168   -0.138
## as.factor(rep)5 -0.336 -0.036   -0.049   -0.126   -0.171
## as.factor(rep)6 -0.385  0.019   -0.003   -0.047   -0.078
## as.factor(rep)7 -0.423 -0.016    0.017   -0.034   -0.029
##           as.fctr(d)6 as.fctr(d)7 as.fctr(r)2 as.fctr(r)3
## as.factor(dow)2
## as.factor(dow)3
## as.factor(dow)4
## as.factor(dow)5
## as.factor(dow)6

```

```
## as.factor(dow)7 0.538
## as.factor(rep)2 -0.060      -0.020
## as.factor(rep)3 -0.093      -0.062      0.574
## as.factor(rep)4 -0.131      -0.054      0.525      0.619
## as.factor(rep)5 -0.151      -0.108      0.531      0.599
## as.factor(rep)6 -0.137      -0.075      0.443      0.522
## as.factor(rep)7 -0.070      -0.093      0.461      0.474
##               as.fctr(r)4 as.fctr(r)5 as.fctr(r)6
## as.factor(dow)2
## as.factor(dow)3
## as.factor(dow)4
## as.factor(dow)5
## as.factor(dow)6
## as.factor(dow)7
## as.factor(rep)2
## as.factor(rep)3
## as.factor(rep)4
## as.factor(rep)5  0.660
## as.factor(rep)6  0.565      0.591
## as.factor(rep)7  0.479      0.503      0.542
##
## Standardized residuals:
##   Min       Q1       Med       Q3       Max
## -0.8204756 -0.6334503 -0.3732255  0.2776025 11.0484393
##
## Residual standard error: 27.55761
## Degrees of freedom: 18417 total; 18404 residual

summary(lme1) #lme with person random effects

## Linear mixed-effects model fit by maximum likelihood
```

```
## Data: meas7

##          AIC      BIC      logLik
##  164031.9 164360.4 -81973.94
##
## Random effects:
## Formula: ~1 | id
##             (Intercept) Residual
## StdDev:    20.94626 17.9077
##
## Correlation Structure: General
## Formula: ~1 | id
## Parameter estimate(s):
## Correlation:
##   1     2     3     4     5     6
## 2  0.029
## 3  0.047  0.183
## 4 -0.125 -0.022  0.220
## 5 -0.029  0.083  0.248  0.275
## 6 -0.042 -0.130  0.090  0.053  0.159
## 7 -0.110 -0.189 -0.072 -0.208 -0.079 -0.045
## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | rep
## Parameter estimates:
##   1     2     3     4     5     6     7
## 1.0000000 0.9576252 1.0606082 1.0067280 1.0606237 0.9944680 0.9021843
## Fixed effects: modvigmin ~ as.factor(dow) + as.factor(rep)
##                 Value Std.Error   DF t-value p-value
## (Intercept) 17.195092 0.6072126 15774 28.318077 0.0000
## as.factor(dow)2 5.415249 0.4702767 15774 11.515027 0.0000
## as.factor(dow)3 5.052471 0.4976649 15774 10.152357 0.0000
```

```

## as.factor(dow)4 4.877019 0.5138789 15774 9.490600 0.0000
## as.factor(dow)5 4.907868 0.5136415 15774 9.555045 0.0000
## as.factor(dow)6 4.647623 0.4972113 15774 9.347380 0.0000
## as.factor(dow)7 2.268769 0.4728769 15774 4.797801 0.0000
## as.factor(rep)2 -0.539643 0.4805191 15774 -1.123041 0.2614
## as.factor(rep)3 -0.308116 0.5049787 15774 -0.610157 0.5418
## as.factor(rep)4 -0.384862 0.5367819 15774 -0.716979 0.4734
## as.factor(rep)5 -0.081071 0.5277859 15774 -0.153607 0.8779
## as.factor(rep)6 -0.831823 0.5105435 15774 -1.629289 0.1033
## as.factor(rep)7 -1.590955 0.4992550 15774 -3.186659 0.0014
## Correlation:
##           (Intr) as.fctr(d)2 as.fctr(d)3 as.fctr(d)4 as.fctr(d)5
## as.factor(dow)2 -0.363
## as.factor(dow)3 -0.376  0.537
## as.factor(dow)4 -0.355  0.500      0.585
## as.factor(dow)5 -0.358  0.471      0.533      0.601
## as.factor(dow)6 -0.337  0.435      0.475      0.529      0.581
## as.factor(dow)7 -0.342  0.442      0.439      0.467      0.505
## as.factor(rep)2 -0.365 -0.095     -0.075     -0.105     -0.054
## as.factor(rep)3 -0.314 -0.074     -0.141     -0.153     -0.135
## as.factor(rep)4 -0.368 -0.030     -0.080     -0.168     -0.138
## as.factor(rep)5 -0.336 -0.036     -0.049     -0.126     -0.171
## as.factor(rep)6 -0.385  0.019     -0.003     -0.047     -0.078
## as.factor(rep)7 -0.423 -0.016     0.017     -0.034     -0.029
##           as.fctr(d)6 as.fctr(d)7 as.fctr(r)2 as.fctr(r)3
## as.factor(dow)2
## as.factor(dow)3
## as.factor(dow)4
## as.factor(dow)5
## as.factor(dow)6
## as.factor(dow)7  0.538

```

```

## as.factor(rep)2 -0.060      -0.020
## as.factor(rep)3 -0.093      -0.062      0.574
## as.factor(rep)4 -0.131      -0.054      0.525      0.619
## as.factor(rep)5 -0.151      -0.108      0.531      0.599
## as.factor(rep)6 -0.137      -0.075      0.443      0.522
## as.factor(rep)7 -0.070      -0.093      0.461      0.474
##               as.fctr(r)4 as.fctr(r)5 as.fctr(r)6
## as.factor(dow)2
## as.factor(dow)3
## as.factor(dow)4
## as.factor(dow)5
## as.factor(dow)6
## as.factor(dow)7
## as.factor(rep)2
## as.factor(rep)3
## as.factor(rep)4
## as.factor(rep)5  0.660
## as.factor(rep)6  0.565      0.591
## as.factor(rep)7  0.479      0.503      0.542
##
## Standardized Within-Group Residuals:
##   Min       Q1       Med       Q3       Max
## -8.4620780 -0.3520519 -0.1234935  0.2129186  9.6612390
##
## Number of Observations: 18417
## Number of Groups: 2631

```

```

meas7$error <- meas7$modvigmin - predict(lme1)
eht <- meas7 %>% group_by(id) %>% summarise(e1=error[1],e2=error[2],e3=error[3],e4=error[4],e5=
# ind <- which(!is.na(eht$e7))

```

```

# boxtest <- rep(0,length(ind))

# for(i in 1:length(ind)){
#   boxtest[i] <- Box.test(unlist(eht[ind[i],-1]),lag=2,type="Ljung-Box")$p.value
# }

# summary(boxtest)

#lag 1 difference

o1a = c(eht$e1,eht$e2,eht$e3,eht$e4,eht$e5,eht$e6)
o1b = c(eht$e2,eht$e3,eht$e4,eht$e5,eht$e6,eht$e7)
cor(o1a,o1b)

## [1] 0.03687864

#lag 2 diff

o2a = c(eht$e1,eht$e2,eht$e3,eht$e4,eht$e5)
o2b = c(eht$e3,eht$e4,eht$e5,eht$e6,eht$e7)
cor(o2a,o2b)

## [1] -0.05977463

#lag 3 diff

o3a = c(eht$e1,eht$e2,eht$e3,eht$e4)
o3b = c(eht$e4,eht$e5,eht$e6,eht$e7)
cor(o3a,o3b)

## [1] -0.1641883

#lag 4 diff

o4a = c(eht$e1,eht$e2,eht$e3)
o4b = c(eht$e5,eht$e6,eht$e7)
cor(o4a,o4b)

## [1] -0.2107862

```

```
#lag 5 diff
o5a = c(eht$e1,eht$e2)
o5b = c(eht$e6,eht$e7)
cor(o5a,o5b)

## [1] -0.2622573

## `geom_smooth()` using method = 'gam'
## Warning: Removed 22850 rows containing non-finite values (stat_smooth).
## Warning: Removed 22850 rows containing missing values (geom_point).

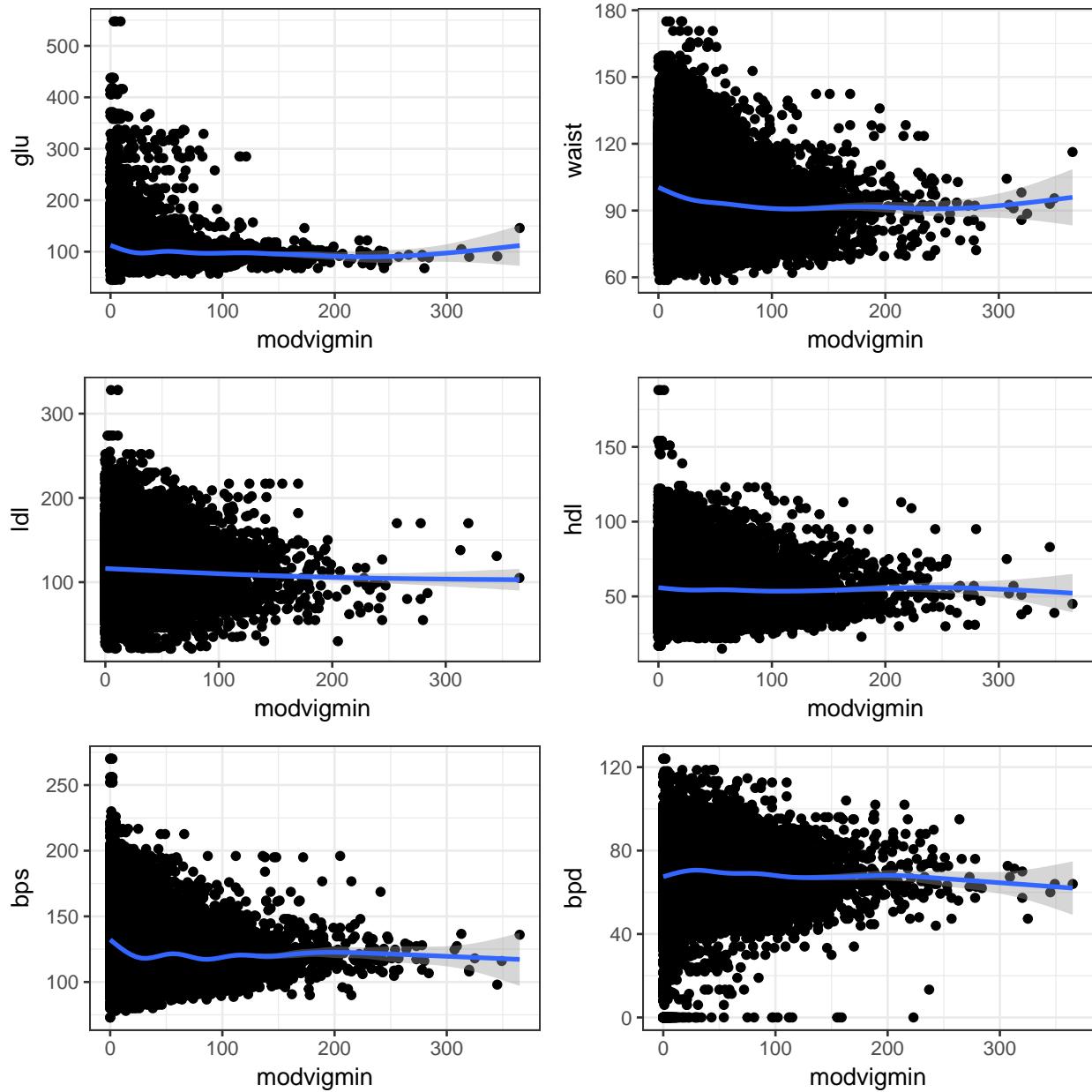
## `geom_smooth()` using method = 'gam'
## Warning: Removed 986 rows containing non-finite values (stat_smooth).
## Warning: Removed 986 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'
## Warning: Removed 23477 rows containing non-finite values (stat_smooth).
## Warning: Removed 23477 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'
## Warning: Removed 1531 rows containing non-finite values (stat_smooth).
## Warning: Removed 1531 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'
## Warning: Removed 1781 rows containing non-finite values (stat_smooth).
## Warning: Removed 1781 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'
## Warning: Removed 1781 rows containing non-finite values (stat_smooth).
## Warning: Removed 1781 rows containing missing values (geom_point).
```



```

## `geom_smooth()` using method = 'gam'

## Warning: Removed 22850 rows containing non-finite values (stat_smooth).

## Warning: Removed 22850 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'

## Warning: Removed 986 rows containing non-finite values (stat_smooth).

## Warning: Removed 986 rows containing missing values (geom_point).

```

```
## `geom_smooth()` using method = 'gam'

## Warning: Removed 23477 rows containing non-finite values (stat_smooth).

## Warning: Removed 23477 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'

## Warning: Removed 22964 rows containing non-finite values (stat_smooth).

## Warning: Removed 22964 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'

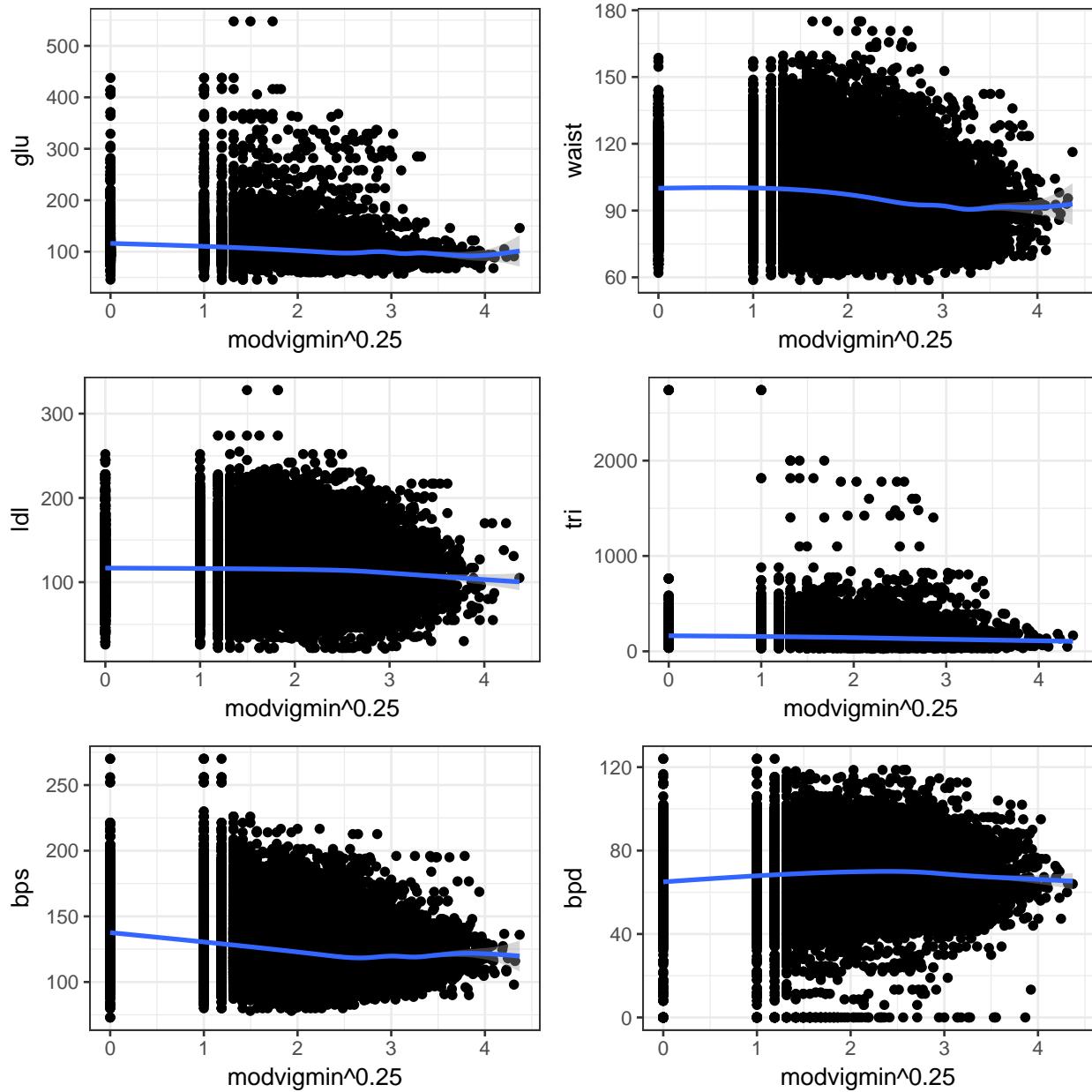
## Warning: Removed 1781 rows containing non-finite values (stat_smooth).

## Warning: Removed 1781 rows containing missing values (geom_point).

## `geom_smooth()` using method = 'gam'

## Warning: Removed 1781 rows containing non-finite values (stat_smooth).

## Warning: Removed 1781 rows containing missing values (geom_point).
```



```
summary(nhanes$wearmin)
```

```
##      Min. 1st Qu. Median      Mean 3rd Qu.      Max.
##    600.0    741.0   839.0    850.6   938.0   1440.0
```

```
summary(meas7$wearmin)
```

```
##      Min. 1st Qu. Median      Mean 3rd Qu.      Max.
##    600.0    787.0   876.0    885.8   965.0   1440.0
```

```
minweartime <- (meas7 %>% group_by(id) %>% summarise(minimum=min(wearmin),avg=mean(wearmin)))  
  
sum(minweartime$minimum[minweartime$id %in% id7complete] > 1000)  
  
## [1] 21  
  
sum(minweartime$minimum[minweartime$id %in% id7complete] > 800)  
  
## [1] 254  
  
sum(minweartime$minimum[minweartime$id %in% id7complete] > 700)  
  
## [1] 663  
  
summary(minweartime$avg[minweartime$id %in% id7complete])  
  
##      Min. 1st Qu. Median      Mean 3rd Qu.      Max.  
##    654.6    821.9   873.6    885.6   928.8  1385.0  
  
minweartime5 <- (meas57 %>% group_by(id) %>% summarise(minimum=min(wearmin),avg=mean(wearmin)))  
  
sum(minweartime5$minimum[minweartime5$id %in% id57complete] > 1000)  
  
## [1] 66  
  
sum(minweartime5$minimum[minweartime5$id %in% id57complete] > 800)  
  
## [1] 691  
  
sum(minweartime5$minimum[minweartime5$id %in% id57complete] > 700)  
  
## [1] 1528  
  
summary(minweartime5$avg[minweartime5$id %in% id57complete])  
  
##      Min. 1st Qu. Median      Mean 3rd Qu.      Max.  
##    624.0    790.3   854.0    865.0   920.6  1398.0
```

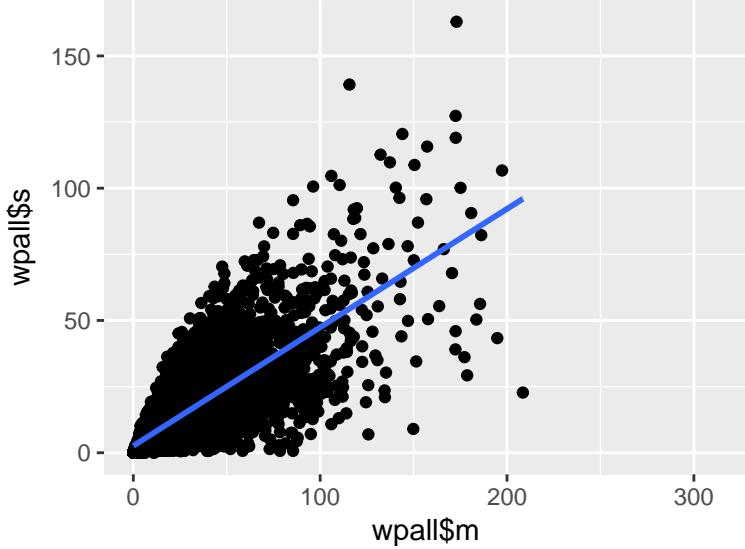
```

wpall <- nhanes %>% group_by(id) %>% summarise(m=mean(modvigmin), s=sd(modvigmin), ml=mean(log(m))
qplot(x=wpall$m, y=wpall$s) + geom_smooth(method="lm")

## Warning: Removed 510 rows containing non-finite values (stat_smooth).

## Warning: Removed 510 rows containing missing values (geom_point).

```



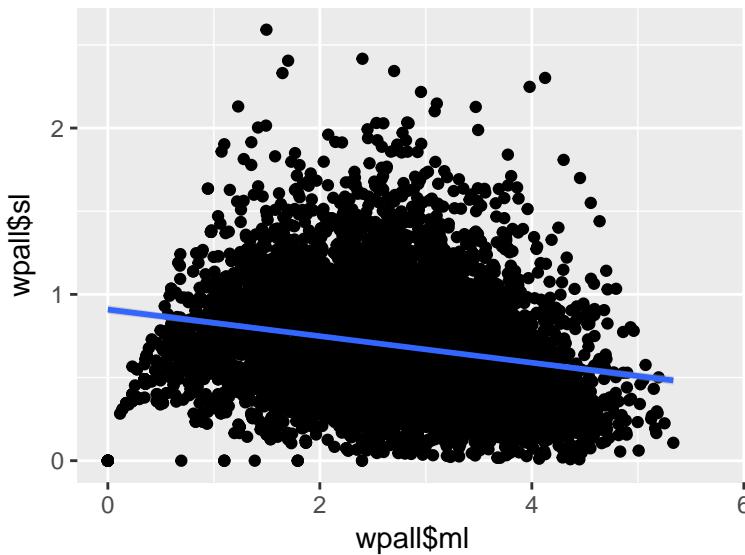
```

qplot(x=wpall$ml, y=wpall$sl)+ geom_smooth(method="lm")

## Warning: Removed 2135 rows containing non-finite values (stat_smooth).

## Warning: Removed 2135 rows containing missing values (geom_point).

```



```

nhanes$bmi <- 1

nhanes$bmi[nhanes$bmi >= 18] <- 2
nhanes$bmi[nhanes$bmi >= 25] <- 3
nhanes$bmi[nhanes$bmi >= 30] <- 4
nhanes$bmi[nhanes$bmi >= 35] <- 5


nhanes$agegroup <- 1
nhanes$agegroup[nhanes$age >= 25] <- 2
nhanes$agegroup[nhanes$age >= 35] <- 3
nhanes$agegroup[nhanes$age >= 45] <- 4
nhanes$agegroup[nhanes$age >= 55] <- 5
nhanes$agegroup[nhanes$age >= 65] <- 6

nhanes %>% group_by(sex) %>% summarise(mean(wearmin),sd(wearmin)/sqrt(length(wearmin)))

## # A tibble: 2 3
##       sex `mean(wearmin)` `sd(wearmin)/sqrt(length(wearmin))` 
##   <int>          <dbl>                  <dbl>
## 1     1            862.4040             1.0745519
## 2     2            839.2255             0.9610608

nhanes %>% group_by(race) %>% summarise(mean(wearmin),sd(wearmin)/sqrt(length(wearmin)))

## # A tibble: 5 3
##       race `mean(wearmin)` `sd(wearmin)/sqrt(length(wearmin))` 
##   <int>          <dbl>                  <dbl>
## 1     1            838.3973             1.504752
## 2     2            837.8630             4.226087
## 3     3            848.6774             0.944356
## 4     4            868.9508             1.864345
## 5     5            855.5710             3.544238

```

```

nhanes %>% group_by(bmigroup) %>% summarise(mean(wearmin),sd(wearmin)/sqrt(length(wearmin)))

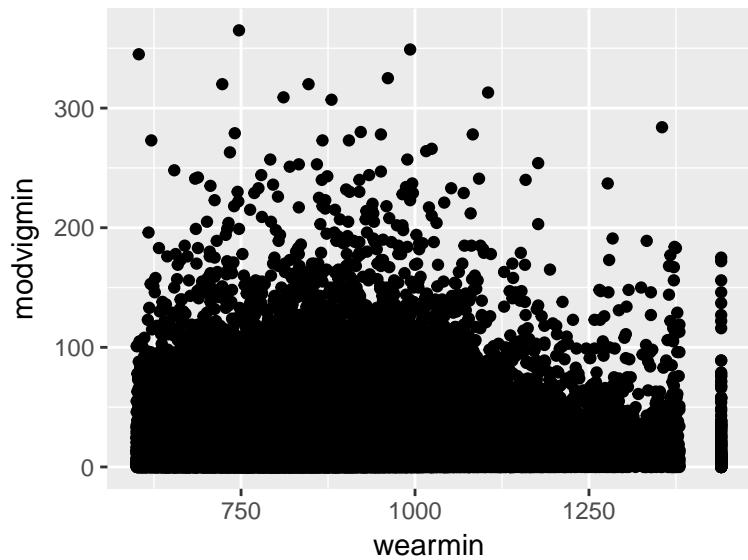
## # A tibble: 5  3
##   bmigroup `mean(wearmin)` `sd(wearmin)/sqrt(length(wearmin))` 
##       <dbl>           <dbl>                                 <dbl>
## 1      1        853.8333                         7.185609
## 2      2        851.4379                         1.257627
## 3      3        855.4751                         1.212399
## 4      4        847.2281                         1.658649
## 5      5        839.8965                         2.096613

nhanes %>% group_by(agegroup) %>% summarise(mean(wearmin),sd(wearmin)/sqrt(length(wearmin)))

## # A tibble: 6  3
##   agegroup `mean(wearmin)` `sd(wearmin)/sqrt(length(wearmin))` 
##       <dbl>           <dbl>                                 <dbl>
## 1      1        841.3575                         2.053093
## 2      2        845.0387                         1.823399
## 3      3        856.7826                         1.809899
## 4      4        876.1550                         1.893967
## 5      5        853.2721                         1.875862
## 6      6        839.1086                         1.365020

#nhanes %>% group_by(sex,race,bmigroup) %>% summarise(mean(wearmin),sd(wearmin)/sqrt(length(wearmin)))
#qplot(x=wearmin,y=modvigmin,data=nhanes)

```



```
qplot(x=wearmin, y=lightmin, data=nhanes)
```

