Systolic Blood Pressure Case Study

MAS II Sample Questions Supplemental Material

A. Case Study Description

This is a hierarchical modeling problem.

The modeling problem is to evaluate the effect of a variety of treatments which are given in different hospitals with different doctors. The treatment result is recorded at the patient level of detail and the outcome at the end of the time period is known for all patients that entered the study with a uniform beginning and ending time period for all patients.

The treatment affects systolic blood pressure. The hospital and doctor can affect the treatment outcome. Not all hospitals and doctors that could use this treatment are included in the data set used to evaluate the different treatments.

For each patient, you are given the beginning systolic pressure, the hospital number, the doctor number within hospital, the treatment (in numeric category), the ending systolic pressure and the change in systolic pressure.

Some exploratory data output and some potential models along with the output from those models is shown.
Table of Contents

A. Description
B. Exploratory Data Output
C. Results of Fitting Models
   C.1 Computation: restricted maximum likelihood Variance grouping: None Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.2 Computation: maximum likelihood Variance grouping: None Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.3 Computation: restricted maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.4 Computation: maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.5 Computation: restricted maximum likelihood Variance grouping: Group #2 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.6 Computation: maximum likelihood Variance grouping: Variance Group #2 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.7 Computation: restricted maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.8 Computation: maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.9 Computation: restricted maximum likelihood Variance grouping: None Treatment group definition: Mean group #1 Random Effect: Include hospitals with doctors nested within hospital
   C.10 Computation: maximum likelihood Variance grouping: None Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
   C.11 Computation: restricted maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
   C.12 Computation: maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
   C.13 Computation: restricted maximum likelihood Variance grouping: Group #2 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
   C.14 Computation: maximum likelihood Variance grouping: Variance Group #2 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
   C.15 Computation: restricted maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
   C.16 Computation: maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
D. Standardized goodness of fit statistics and fitted betas
B. Create Exploratory Data Output

This section is included to allow the candidate to understand the nature of the data underlying the modeling output.

Input data set

The first table shown is sample of the input data set which displays only the first ten records. The Treatment number is shown in the first column. Later columns in the data set show potential groupings for the eight treatments that are shown with separate potential treatment groups for both the mean effect and the standard errors: mean_grp_X or var_grp_X. The linear mixed models to be reviewed require that the variables by transformed from numeric to categorical groups to inform the statistical routines that 1 is really just a category “1” and there is no cardinal ordering of the treatments or treatment groups with an “F” inserted in the variable name to clarify that particular variable has been transformed from numeric to categorical. For example, Mean_F_G_1 is the variable for treatments grouped for use in estimating the mean effect for treatments placed in group one with that numerical assignment transformed into a categorical variable.
## # A tibble: 1,680 x 21
## #  Treatment hospital doctor beg_systolic end_systolic mean_grp_1 mean_grp_2 mean_grp_3
## #       <int>    <int>  <int>        <dbl>        <dbl>      <int>      <int>      <int>
##  1         1        0      0        160.         155.           1        1         1
##  2         2        0      0        115.         113.           0        0         0
##  3         3        0      0        126.         123.           1        1         1
##  4         4        0      0        100.0         96.7          1        1         1
##  5         5        0      0        139.         140.           1        1         1
##  6         6        0      0        131.         128.           1        1         1
##  7         7        0      0        128.         126.           1        1         1
##  8         8        0      0        117.         113.           1        1         1
##  9         1        0      1        164.         162.           1        1         1
## 10         2        0      1        139.         135.           0        0         0
## #  var_grp_1 change_systolic Doctor_F Hospital_F Treatment_F Mean_F_G_1
## #        <int>           <dbl> <fct>    <fct>      <fct>       <fct>
##  1         0            -5.66 0        0          1           1
##  2         0            -2.37 0        0          2           0
##  3         0            -2.98 0        0          3           1
##  4         0            -3.33 0        0          4           1
##  5         1             1.36 0        0          5           1
##  6         1            -2.48 0        0          6           1
##  7         1            -2.23 0        0          7           1
##  8         1            -4.07 0        0          8           1
##  9         0            -2.02 1        0          1           1
## 10         0            -3.65 1        0          2           0
## #  Var_F_G_1 var_grp_2 var_grp_3 mean_grp_2 mean_grp_3 Mean_F_G_2
## #    <fct>         <dbl>     <dbl>      <dbl>      <dbl> <fct>
##  1 0                0.        0.         1.         1. 1
##  2 0                1.        0.         0.         0. 0
##  3 0                1.        1.         1.         1. 1
##  4 0                1.        1.         1.         2. 1
##  5 1                2.        1.         1.         3. 1
##  6 1                2.        2.         1.         2. 1
##  7 1                2.        2.         1.         3. 1
##  8 1                2.        3.         2.         3. 2
##  9 0                0.        0.         1.         1. 1
## 10 0                1.        0.         0.         0. 0
## #  Var_F_G_2 Mean_F_G_3 Var_F_G_3
## #    <fct>      <fct>      <fct>
##  1 1           1          0
##  2 1           0          0
##  3 1           1          1
##  4 1           2          1
##  5 2           3          1
##  6 2           2          2
##  7 2           3          2
## Summary of the input data set

The table below shows for each column in the input data set statistics that display the characteristics of the values in that column.

```
# Treatment    hospital    doctor    beg_systolic
# Min.   :1.00 Min. : 0 Min. :0.0 Min. : 62.69
# 1st Qu.:2.75 1st Qu.: 5 1st Qu.:2.0 1st Qu.:106.41
# Median :4.50 Median :10 Median :4.5 Median :119.78
# Mean   :4.50 Mean :10 Mean :4.5 Mean :119.96
# 3rd Qu.:6.25 3rd Qu.:15 3rd Qu.:7.0 3rd Qu.:133.32
# Max.   :8.00 Max. :20 Max. :9.0 Max. :183.60
#
# end_systolic    mean_grp_1    var_grp_1    change_systolic
# Min. : 52.2 Min. :0.000 Min. :0.0 Min. : -17.7001
# 1st Qu.:102.1 1st Qu.:1.000 1st Qu.:0.0 1st Qu.: -7.2384
# Median :116.2 Median :1.000 Median :0.0 Median : -3.8417
# Mean   :116.1 Mean :0.875 Mean :0.5 Mean : -3.8600
# 3rd Qu.:129.7 3rd Qu.:1.000 3rd Qu.:1.0 3rd Qu.: -0.4965
# Max.   :184.6 Max. :1.000 Max. :1.0 Max. :  11.2164
#
# Doctor_F   Hospital_F   Treatment_F   Mean_F_G_1 Var_F_G_1
# 0     :168     0     : 80     1     :210 0: 210 0:840
# 1     :168     1     : 80     2     :210 1:1470 1:840
# 2     :168     2     : 80     3     :210
# 3     :168     3     : 80     4     :210
# 4     :168     4     : 80     5     :210
# 5     :168     5     : 80     6     :210
# (Other):672 (Other):1200 (Other):420
# var.grp.2   var.grp.3   mean.grp.2   mean.grp.3   Mean_F_G_2
# Min. :0.000 Min. :0.000 Min. :0 Min. :0.000 0: 210
# 1st Qu.:1.000 1st Qu.:0.75 1st Qu.:1 1st Qu.:1.000 1:1260
# Median :1.500 Median :1.00 Median :1 Median :2.000 2: 210
# Mean   :1.375 Mean :1.25 Mean :1 Mean :1.875
# 3rd Qu.:2.000 3rd Qu.:2.00 3rd Qu.:1 3rd Qu.:3.000
# Max.   :2.000 Max. :3.00 Max. :2 Max. :3.000
#
# Var_F_G_2   Mean_F_G_3   Var_F_G_3
# 0:210   0:210   0:420
# 1:630   1:420   1:630
# 2:840   2:420   2:420
# 3:630   3:210
This is a summary of the results of each of the treatments across all hospitals and doctors.

One should note that some of the treatments have similar effects leading to the question of are there natural groupings of the treatments when evaluating the effectiveness. Three sets of potential groups for both the mean and variance effects to be modeled in the linear mixed models as shown below were created from reviewing this table.

### # A tibble: 8 x 7
###   Treatment_F mean_chng med_chgn min_chgn max_chng Std_Dev_Chng
###   <fct>           <dbl>    <dbl>    <dbl>        <dbl>        <dbl>
### 1 1               -1.80    -2.00    -12.4         7.38         3.85
### 2 2               0.306    0.353   -9.98         11.2          4.03
### 3 3               -1.26   -1.14    -10.5         9.12          3.83
### 4 4               -3.27   -3.04    -14.7         5.74          3.88
### 5 5               -6.41   -6.52    -14.3         7.90          3.67
### 6 6               -4.39   -4.20    -14.9         5.61          4.07
### 7 7               -4.97   -5.00    -17.2         6.95          3.79
### 8 8               -9.09   -9.42    -17.7     -0.0202        3.55
### Num_Observations <int>
### 1 210
### 2 210
### 3 210
### 4 210
### 5 210
### 6 210
### 7 210
### 8 210

This shows a potential set of groupings for the treatment mean and variance

The groupings displayed will be used in subsequent models. Each treatment is mapped to three different options for either the mean or variance grouping.

### # A tibble: 8 x 7
###   Treatment_F Mean_F_G_1 Var_F_G_1 Mean_F_G_2 Var_F_G_2 Mean_F_G_3
###   <fct>            <dbl>     <dbl>      <dbl>     <dbl>      <dbl>
### 1 1               1.        0.         1.        0.         1.
### 2 2               0.        0.         1.        0.         0.
### 3 3               1.        0.         1.        1.         1.
### 4 4               1.        0.         1.        1.         2.
### 5 5               1.        1.         1.        2.         3.
### 6 6               1.        1.         2.        2.         2.
### 7 7               1.        1.         1.        2.         3.
### 8 8               1.        1.         2.        2.         3.
<table>
<thead>
<tr>
<th>Var_F_G_3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.</td>
</tr>
<tr>
<td>0.</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
</tbody>
</table>
Create Box Whisker plots of the change in systolic pressure by Treatment and then by Hospital.
C. This section will display the results of fitting different models.

The items that will vary across models include:

Computation method: maximum likelihood or restricted maximum likelihood

Variance grouping with different treatments assigned different variance groups

Treatment groups with different treatments assigned to different mean treatment groups Include or exclude hospitals with doctors nested within hospital as a random effect

When there is no grouping of the eight treatments included in the study, it is called the “Full Model”.

In all cases, the models were fit using the lme option within the nlme package in R. The results are displayed using the summary function to generate standardized goodness of fit statistics and the fitted betas for each model.

The same set of graphs displaying the behavior of the residuals will be shown for each model.

The models will be numbered and the definition of the model will precede the model output.

Create Model 1

Model Definition: Computation method: restricted maximum likelihood Variance grouping: None Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

### Standarized Residuals vs. Fitted Systolic Change

**Model_1**
Create Model 2

Model Definition: Computation method: maximum likelihood Variance grouping: None Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

Standarized Residuals vs. Fitted Systolic Change

Model_2
Create Model 3

Model Definition: Computation method: restricted maximum likelihood Variance grouping: Variance Group #1
Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

Standarized Residuals vs. Fitted Systolic Change
Model_3
Create Model 4

Model Definition: Computation method: maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

Standarized Residuals vs. Fitted Systolic Change

Model_4
Create Model 5

Model Definition: Computation method: restricted maximum likelihood Variance grouping: Group #2
Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

![Standardized Residuals vs. Fitted Systolic Change]

Model_5
Create Model 6

Model Definition: Computation method: maximum likelihood Variance grouping: Variance Group #2 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
Create Model 7

Model Definition: Computation method: restricted maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

![Standardized Residuals vs. Fitted Systolic Change](image)
Standarized Residuals vs. Treatment

QQ Plot for Standarized Residuals
Create Model 8

Model Definition: Computation method: maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital

Standarized Residuals vs. Fitted Systolic Change

Model_8
Create Model 9

Model Definition: Computation method: restricted maximum likelihood Variance grouping: None
Treatment group definition: Mean group #1 Random Effect: Include hospitals with doctors nested within hospital

Standarized Residuals vs. Fitted Systolic Change

Model_9
Create Model 10

Model Definition: Computation method: maximum likelihood Variance grouping: None Treatment group definition: Full model Random Effect: Include hospitals with doctors nested within hospital
Standardized Residuals vs. Treatment

Model_10

QQ Plot for Standardized Residuals

Model_10
Create Model 11

Model Definition: Computation method: restricted maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
Create Model 12

Model Definition: Computation method: maximum likelihood Variance grouping: Variance Group #1 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital

![Standardized Residuals vs. Fitted Systolic Change](image-url)
Create Model 13

Model Definition: Computation method: restricted maximum likelihood Variance grouping: Group #2 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
Create Model 14

Model Definition: Computation method: maximum likelihood Variance grouping: Variance Group #2
Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital

![Standardized Residuals vs. Fitted Systolic Change](image)
Create Model 15

Model Definition: Computation method: restricted maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
Create Model 16

Model Definition: Computation method: maximum likelihood Variance grouping: Variance Group #3 Treatment group definition: Mean Group #1 Random Effect: Include hospitals with doctors nested within hospital
D. Standardized goodness of fit statistics and fitted betas

Model 1 Results
## Linear mixed-effects model fit by REML
## Data: systolic_g
## AIC      BIC    logLik
## 9300.655 9360.294 -4639.327
##
## Random effects:
## Formula: ~1 | Hospital_F
##  (Intercept)
## StdDev:  0.4307059
##
## Formula: ~1 | Doctor_F %in% Hospital_F
##  (Intercept) Residual
## StdDev:    0.187263 3.810025
##
## Fixed effects: change_systolic ~ Treatment_F
##                  Value Std.Error   DF   t-value p-value
## (Intercept)    -1.795012 0.2795101 1463 -6.421992  0.0000
## Treatment_F2   2.101111 0.3718204 1463  5.650875  0.0000
## Treatment_F3   0.533483 0.3718204 1463  1.434788  0.1516
## Treatment_F4   -1.476657 0.3718204 1463 -3.971425  0.0001
## Treatment_F5   -4.615913 0.3718204 1463 -12.414362  0.0000
## Treatment_F6   -2.595449 0.3718204 1463 -6.980384  0.0000
## Treatment_F7   -3.172534 0.3718204 1463 -8.532437  0.0000
## Treatment_F8   -7.294017 0.3718204 1463 -19.617043  0.0000
##
## Correlation:
##  (Intr) Trt_F2 Trt_F3 Trt_F4 Trt_F5 Trt_F6 Trt_F7
## Treatment_F2       -0.665
## Treatment_F3       -0.665  0.500
## Treatment_F4       -0.665  0.500  0.500
## Treatment_F5       -0.665  0.500  0.500  0.500
## Treatment_F6       -0.665  0.500  0.500  0.500  0.500
## Treatment_F7       -0.665  0.500  0.500  0.500  0.500  0.500
## Treatment_F8       -0.665  0.500  0.500  0.500  0.500  0.500  0.500
##
## Standardized Within-Group Residuals:
##  Min      Q1     Q3    Max
## -3.151350 0.690631 0.001801 0.687151 3.751340
##
## Number of Observations: 1680
## Number of Groups:
##  Hospital_F Doctor_F %in% Hospital_F
##           21 210
## Linear mixed-effects model fit by maximum likelihood

### Data: systolic_g

<table>
<thead>
<tr>
<th></th>
<th>AIC</th>
<th>BIC</th>
<th>loglik</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9294.656</td>
<td>9354.348</td>
<td>-4636.328</td>
</tr>
</tbody>
</table>

### Random effects:

- Formula: ~1 | Hospital_F
- (Intercept)
- StdDev: 0.4097239

- Formula: ~1 | Doctor_F %in% Hospital_F
- (Intercept) Residual
- StdDev: 0.2090384 3.800944

### Fixed effects: change_systolic ~ Treatment_F

<table>
<thead>
<tr>
<th>Value</th>
<th>Std.Error</th>
<th>DF</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-1.795012</td>
<td>0.2781484</td>
<td>1463</td>
<td>-6.453430</td>
</tr>
<tr>
<td>Treatment_F2</td>
<td>2.101111</td>
<td>0.3718205</td>
<td>1463</td>
<td>5.650874</td>
</tr>
<tr>
<td>Treatment_F3</td>
<td>0.533483</td>
<td>0.3718205</td>
<td>1463</td>
<td>1.434788</td>
</tr>
<tr>
<td>Treatment_F4</td>
<td>-1.476657</td>
<td>0.3718205</td>
<td>1463</td>
<td>-3.971424</td>
</tr>
<tr>
<td>Treatment_F5</td>
<td>-4.615913</td>
<td>0.3718205</td>
<td>1463</td>
<td>-12.414359</td>
</tr>
<tr>
<td>Treatment_F6</td>
<td>-2.595449</td>
<td>0.3718205</td>
<td>1463</td>
<td>-6.980382</td>
</tr>
<tr>
<td>Treatment_F7</td>
<td>-3.172534</td>
<td>0.3718205</td>
<td>1463</td>
<td>-8.532435</td>
</tr>
<tr>
<td>Treatment_F8</td>
<td>-7.294017</td>
<td>0.3718205</td>
<td>1463</td>
<td>-19.617038</td>
</tr>
</tbody>
</table>

### Correlation:

- (Intr) Trt_F2 Trt_F3 Trt_F4 Trt_F5 Trt_F6 Trt_F7
- Treatment_F2 -0.668
- Treatment_F3 -0.668 0.500
- Treatment_F4 -0.668 0.500 0.500
- Treatment_F5 -0.668 0.500 0.500 0.500
- Treatment_F6 -0.668 0.500 0.500 0.500 0.500
- Treatment_F7 -0.668 0.500 0.500 0.500 0.500 0.500
- Treatment_F8 -0.668 0.500 0.500 0.500 0.500 0.500 0.500

### Standardized Within-Group Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>Q1</th>
<th>Med</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.157968766</td>
<td>-0.690475844</td>
<td>0.002506614</td>
<td>0.689894226</td>
<td>3.759326289</td>
</tr>
</tbody>
</table>

### Number of Observations: 1680

### Number of Groups:

<table>
<thead>
<tr>
<th>Hospital_F Doctor_F %in% Hospital_F</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
</tr>
</tbody>
</table>
Model 3 Results

```r
## Linear mixed-effects model fit by REML
## Data: systolic_g
##   AIC     BIC    logLik
## 9301.299 9366.36 -4638.649

## Random effects:
## Formula: ~1 | Hospital_F
##             (Intercept) StdDev: 0.4394142
## Formula: ~1 | Doctor_F %in% Hospital_F
##             (Intercept) Residual StdDev: 0.2047342 3.885634

## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_1
## Parameter estimates:
## 0 1
## 1.000000 0.9600076

## Fixed effects: change_systolic ~ Treatment_F
##             Value Std.Error   DF   t-value p-value
## (Intercept) -1.795012  0.2851142 1463 -6.29576 0.0000
## Treatment_F2  2.101111  0.3791991 1463  5.540917 0.0000
## Treatment_F3  0.533483  0.3791991 1463  1.406869 0.1597
## Treatment_F4 -4.615913  0.3719916 1463 -12.418588 0.0000
## Treatment_F5  0.371693  0.3719916 1463  0.371693 0.7100
## Treatment_F6  0.371693  0.3719916 1463  0.371693 0.7100
## Treatment_F7  0.371693  0.3719916 1463  0.371693 0.7100
## Treatment_F8 -0.2794017 0.3716939 1463 -19.623721 0.0000

## Correlation:
##             (Intr) Trt_F2 Trt_F3 Trt_F4 Trt_F5 Trt_F6 Trt_F7
## Treatment_F2 -0.665
## Treatment_F3 -0.665  0.500
## Treatment_F4 -0.665  0.500  0.500
## Treatment_F5 -0.678  0.510  0.510  0.510
## Treatment_F6 -0.678  0.510  0.510  0.510  0.520
## Treatment_F7 -0.678  0.510  0.510  0.510  0.520  0.520
## Treatment_F8 -0.678  0.510  0.510  0.510  0.520  0.520  0.520

## Standardized Within-Group Residuals:
##              Min Q1 Med Q3 Max
## -3.212146733 -0.684307656 0.003524133 0.684495444 3.826598621

## Number of Observations: 1680
## Number of Groups:
## Hospital_F Doctor_F %in% Hospital_F
## 21 210
```
Model 4 Results

## Linear mixed-effects model fit by maximum likelihood
## Data: systolic_g
## AIC      BIC    logLik
## 9295.31 9360.429 -4635.655

## Random effects:
## Formula: ~1 | Hospital_F
##   (Intercept)
## StdDev:  0.4183657

## Formula: ~1 | Doctor_F %in% Hospital_F
##   (Intercept) Residual
## StdDev:  0.2246463 3.8759

## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_1
## Parameter estimates:
##  0        1
## 1.000000 0.960247

## Fixed effects: change_systolic ~ Treatment_F
##                  Value Std.Error   DF  t-value p-value
## (Intercept)    -1.795012 0.2837157 1463 -6.326797  0.0000  
## Treatment_F2   2.101111 0.3791530 1463  5.541591  0.0000  
## Treatment_F3   0.533483 0.3791530 1463  1.407040  0.1596  
## Treatment_F4   1.476657 0.3791530 1463  3.894621  0.0001  
## Treatment_F5  -4.615913 0.3791530 1463 -12.418613  0.0000  
## Treatment_F6  -2.595449 0.3791530 1463  -6.982774  0.0000  
## Treatment_F7  -3.172534 0.3791530 1463 - 8.535359  0.0000  
## Treatment_F8  -7.294017 0.3791530 1463 -19.623761  0.0000  

## Correlation:
##              (Intr)  Trt_F2  Trt_F3  Trt_F4  Trt_F5  Trt_F6  Trt_F7
## Treatment_F2  0.668
## Treatment_F3 -0.668  0.500
## Treatment_F4 -0.668  0.500  0.500
## Treatment_F5 -0.682  0.510  0.510  0.510
## Treatment_F6 -0.682  0.510  0.510  0.510  0.510
## Treatment_F7 -0.682  0.510  0.510  0.510  0.510  0.520
## Treatment_F8 -0.682  0.510  0.510  0.510  0.520  0.520  0.520

## Standardized Within-Group Residuals:
##          Min           Q1          Med           Q3          Max
## -3.218461886  -0.684686643  0.003120456  0.684527669  3.834278498

## Number of Observations: 1680
## Number of Groups:
## Hospital_F  Doctor_F %in% Hospital_F
## 21          210
## Model 5 Results

### Linear mixed-effects model fit by REML

Data: systolic_g

<table>
<thead>
<tr>
<th>AIC</th>
<th>BIC</th>
<th>logLik</th>
</tr>
</thead>
<tbody>
<tr>
<td>9303.232</td>
<td>9373.715</td>
<td>-4638.616</td>
</tr>
</tbody>
</table>

### Random effects:

Formula: ~1 | Hospital_F

(Intercept)

StdDev: 0.4391219

Formula: ~1 | Doctor_F %in% Hospital_F

(Intercept) Residual

StdDev: 0.2043875 3.842886

### Variance function:

Structure: Different standard deviations per stratum

Formula: ~1 | Var_F_G_2

### Parameter estimates:

<p>| | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1.000000</td>
<td>1.048160</td>
<td>0.970957</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Fixed effects: change_systolic ~ Treatment_F

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Std.Error</th>
<th>DF</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-1.795012</td>
<td>0.2823189</td>
<td>1463</td>
<td>-6.358100</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F2</td>
<td>2.101111</td>
<td>0.3778157</td>
<td>1463</td>
<td>5.561206</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F3</td>
<td>0.533483</td>
<td>0.3778157</td>
<td>1463</td>
<td>1.412020</td>
<td>0.1582</td>
</tr>
<tr>
<td>Treatment_F4</td>
<td>-1.476657</td>
<td>0.3778157</td>
<td>1463</td>
<td>-3.908405</td>
<td>0.0001</td>
</tr>
<tr>
<td>Treatment_F5</td>
<td>-4.615913</td>
<td>0.3695732</td>
<td>1463</td>
<td>-12.489849</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F6</td>
<td>-2.595449</td>
<td>0.3695732</td>
<td>1463</td>
<td>-7.022829</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F7</td>
<td>-3.172534</td>
<td>0.3695732</td>
<td>1463</td>
<td>-8.584320</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F8</td>
<td>-7.294017</td>
<td>0.3695732</td>
<td>1463</td>
<td>-19.736327</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

### Correlation:

<table>
<thead>
<tr>
<th></th>
<th>(Intr)</th>
<th>Trt_F2</th>
<th>Trt_F3</th>
<th>Trt_F4</th>
<th>Trt_F5</th>
<th>Trt_F6</th>
<th>Trt_F7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trt_F2</td>
<td>-0.659</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trt_F3</td>
<td>-0.659</td>
<td>0.493</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trt_F4</td>
<td>-0.659</td>
<td>0.493</td>
<td>0.493</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trt_F5</td>
<td>-0.674</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trt_F6</td>
<td>-0.674</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td>0.515</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trt_F7</td>
<td>-0.674</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td>0.515</td>
<td>0.515</td>
<td></td>
</tr>
<tr>
<td>Trt_F8</td>
<td>-0.674</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td>0.515</td>
<td>0.515</td>
<td>0.515</td>
</tr>
</tbody>
</table>

### Standardized Within-Group Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>Q1</th>
<th>Med</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.21082407</td>
<td>-0.68192046</td>
<td>0.00305779</td>
<td>0.68466789</td>
<td>3.82591848</td>
</tr>
</tbody>
</table>

### Number of Observations: 1680

<table>
<thead>
<tr>
<th>Hospital_F</th>
<th>Doctor_F %in% Hospital_F</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>210</td>
</tr>
</tbody>
</table>
### Linear mixed-effects model fit by maximum likelihood

*Data: systolic_g*

#### AIC      BIC    logLik
9297.243 9367.789  -4635.622

#### Random effects:

#### Formula: ~1 | Hospital_F

(Intercept)

StdDev:  0.4180693

#### Formula: ~1 | Doctor_F %in% Hospital_F

(Intercept) Residual

StdDev:  0.2243367 3.833071

#### Variance function:

Structure: Different standard deviations per stratum

#### Formula: ~1 | Var_F_G_2

Parameter estimates:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0000000</td>
<td>1.0148817</td>
<td>0.9709859</td>
</tr>
</tbody>
</table>

#### Fixed effects: change_systolic ~ Treatment_F

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Std.Error</th>
<th>DF</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-1.795012</td>
<td>0.2808955</td>
<td>1463</td>
<td>-6.390318</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F2</td>
<td>2.101111</td>
<td>0.3777636</td>
<td>1463</td>
<td>5.561973</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F3</td>
<td>0.533483</td>
<td>0.3777636</td>
<td>1463</td>
<td>1.412215</td>
<td>0.158</td>
</tr>
<tr>
<td>Treatment_F4</td>
<td>-1.476657</td>
<td>0.3777636</td>
<td>1463</td>
<td>-3.908945</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F5</td>
<td>-4.615913</td>
<td>0.3695637</td>
<td>1463</td>
<td>-12.490171</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F6</td>
<td>-2.595449</td>
<td>0.3695637</td>
<td>1463</td>
<td>-7.023010</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F7</td>
<td>-3.172534</td>
<td>0.3695637</td>
<td>1463</td>
<td>-8.584540</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F8</td>
<td>-7.294017</td>
<td>0.3695637</td>
<td>1463</td>
<td>-19.736835</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Correlation:

<table>
<thead>
<tr>
<th></th>
<th>(Intr)</th>
<th>Trt_F2</th>
<th>Trt_F3</th>
<th>Trt_F4</th>
<th>Trt_F5</th>
<th>Trt_F6</th>
<th>Trt_F7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment_F2</td>
<td>0.662</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment_F3</td>
<td>-0.662</td>
<td>0.493</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment_F4</td>
<td>-0.662</td>
<td>0.493</td>
<td>0.493</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment_F5</td>
<td>-0.677</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment_F6</td>
<td>-0.677</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td>0.515</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment_F7</td>
<td>-0.677</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td>0.515</td>
<td>0.515</td>
<td></td>
</tr>
<tr>
<td>Treatment_F8</td>
<td>-0.677</td>
<td>0.504</td>
<td>0.504</td>
<td>0.504</td>
<td>0.515</td>
<td>0.515</td>
<td>0.515</td>
</tr>
</tbody>
</table>

#### Standardized Within-Group Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Q1</th>
<th>Med</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-3.217175106</td>
<td>-0.683870891</td>
<td>0.002868699</td>
<td>0.684755910</td>
<td>3.833637003</td>
</tr>
</tbody>
</table>

#### Number of Observations: 1680

#### Number of Groups:

<table>
<thead>
<tr>
<th></th>
<th>Hospital_F</th>
<th>Doctor_F %in% Hospital_F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21</td>
<td>210</td>
</tr>
</tbody>
</table>
Model 7 Results

## Linear mixed-effects model fit by REML

## Data: systolic_g

### AIC  BIC  logLik
### 9303.271 9379.175 -4637.635

## Random effects:
## Formula: ~1 | Hospital_F
## (Intercept)
## StdDev:  0.4237209

## Formula: ~1 | Doctor_F %in% Hospital_F
## (Intercept) Residual
## StdDev:  0.2055382 3.941013

## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_3
## Parameter estimates:
## 0  1  2  3
## 1.0000000 0.9565403 0.9806869 0.8981365

## Fixed effects: change_systolic ~ Treatment_F

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Std.Error</th>
<th>DF</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>-1.795012</td>
<td>0.2875945</td>
<td>1463</td>
<td>-6.241467</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F2</td>
<td>2.101111</td>
<td>0.3846035</td>
<td>1463</td>
<td>5.463057</td>
<td>0.000</td>
</tr>
<tr>
<td>Treatment_F3</td>
<td>0.533483</td>
<td>0.3763389</td>
<td>1463</td>
<td>1.417561</td>
<td>0.1565</td>
</tr>
<tr>
<td>Treatment_F4</td>
<td>-1.476657</td>
<td>0.3763389</td>
<td>1463</td>
<td>-3.923742</td>
<td>0.0001</td>
</tr>
<tr>
<td>Treatment_F5</td>
<td>-4.615913</td>
<td>0.3763389</td>
<td>1463</td>
<td>-12.265310</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F6</td>
<td>-2.595449</td>
<td>0.3809077</td>
<td>1463</td>
<td>-6.813854</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F7</td>
<td>-3.172534</td>
<td>0.3809077</td>
<td>1463</td>
<td>-8.328880</td>
<td>0.0000</td>
</tr>
<tr>
<td>Treatment_F8</td>
<td>-7.294017</td>
<td>0.3655402</td>
<td>1463</td>
<td>-19.954077</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

## Correlation:

<table>
<thead>
<tr>
<th>(Intr) Trt_F2 Trt_F3 Trt_F4 Trt_F5 Trt_F6 Trt_F7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment_F2 0.669</td>
</tr>
<tr>
<td>Treatment_F3 -0.683 0.511</td>
</tr>
<tr>
<td>Treatment_F4 -0.683 0.511 0.522</td>
</tr>
<tr>
<td>Treatment_F5 -0.683 0.511 0.522 0.522</td>
</tr>
<tr>
<td>Treatment_F6 -0.675 0.505 0.516 0.516 0.516</td>
</tr>
<tr>
<td>Treatment_F7 -0.675 0.505 0.516 0.516 0.516 0.510</td>
</tr>
<tr>
<td>Treatment_F8 -0.704 0.526 0.538 0.538 0.538 0.531 0.531</td>
</tr>
</tbody>
</table>

## Standardized Within-Group Residuals:

<table>
<thead>
<tr>
<th>Min Q1</th>
<th>Med Q3 Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.10698726</td>
<td>-0.68414823 0.00284928 0.69816803 3.78725057</td>
</tr>
</tbody>
</table>

## Number of Observations: 1680

## Number of Groups:

<table>
<thead>
<tr>
<th>Hospital_F Doctor_F %in% Hospital_F</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
</tr>
</tbody>
</table>
Model 8 Results

## Linear mixed-effects model fit by maximum likelihood
## Data: systolic_g
## AIC      BIC   logLik
## 9297.24 9373.212 -4634.62

### Random effects:
### Formula: ~1 | Hospital_F
### (Intercept)
### StdDev: 0.4024908

### Formula: ~1 | Doctor_F %in% Hospital_F
### (Intercept) Residual
### StdDev: 0.2254259 3.93075

### Variance function:
### Structure: Different standard deviations per stratum
### Formula: ~1 | Var_F_G_3
### Parameter estimates:
### 0  1  2  3
### 1.000000 0.9567178 0.9813402 0.8980579

### Fixed effects: change_systolic ~ Treatment_F
### Value Std.Error DF t-value p-value
### (Intercept) -1.795012 0.2862194 1463 -6.271453 0.0000
### Treatment_F2  2.101111 0.3845186 1463  5.464264 0.0000
### Treatment_F3  0.533483 0.3762892 1463  1.417749 0.1565
### Treatment_F4 -1.476657 0.3762892 1463 -3.924261 0.0001
### Treatment_F5 -4.615913 0.3762892 1463 -12.266931 0.0000
### Treatment_F6 -2.595449 0.3809479 1463 -6.813134 0.0000
### Treatment_F7 -3.172534 0.3809479 1463 -8.327999 0.0000
### Treatment_F8 -7.294017 0.3654452 1463 -19.959264 0.0000
### Correlation:
### (Intr) Trt_F2 Trt_F3 Trt_F4 Trt_F5 Trt_F6 Trt_F7
### Treatment_F2 -0.672
### Treatment_F3 -0.686 0.511
### Treatment_F4 -0.686 0.511 0.522
### Treatment_F5 -0.686 0.511 0.522 0.522
### Treatment_F6 -0.678 0.505 0.516 0.516 0.516
### Treatment_F7 -0.678 0.505 0.516 0.516 0.516 0.509
### Treatment_F8 -0.707 0.526 0.538 0.538 0.538 0.531 0.531

### Standardized Within-Group Residuals:
### Min Q1 Med Q3 Max
### -3.11220205 -0.68621500 0.00228202 0.70233058 3.79550328

### Number of Observations: 1680
### Number of Groups:
### Hospital_F Doctor_F %in% Hospital_F
### 21 210
Model 9 Results

## Linear mixed-effects model fit by REML
## Data: systolic_g
##   AIC      BIC     logLik
## 9827.508 9854.635 -4908.754
##
## Random effects:
## Formula: ~1 | Hospital_F
## (Intercept) StdDev: 0.3453025
##
## Formula: ~1 | Doctor_F %in% Hospital_F
## (Intercept) Residual StdDev: 0.0003007451 4.483215
##
## Fixed effects: change_systolic ~ Mean_F_G_1
##                         Value Std.Error   DF  t-value p-value
## (Intercept)    0.306099 0.3184154 1469 0.96132  0.3365
## Mean_F_G_11    -4.761266 0.3307318 1469 -14.39616  0.0000
##
## Correlation:
##                (Intr)
## Mean_F_G_11    -0.909
##
## Standardized Within-Group Residuals:
##                  Min          Q1        Med         Q3        Max
## Number of Observations: 1680
## Number of Groups:
##               Hospital_F Doctor_F %in% Hospital_F
##                       21                     210
Model 10 Results

## Linear mixed-effects model fit by maximum likelihood
## Data: systolic_g
##        AIC      BIC    logLik
##   9824.908 9852.041 -4907.454
##
## Random effects:
## Formula: ~1 | Hospital_F
##        (Intercept)
## StdDev:  0.3189744
##
## Formula: ~1 | Doctor_F %in% Hospital_F
##        (Intercept) Residual
## StdDev: 0.0002603604 4.481864
##
## Fixed effects: change_systolic ~ Mean_F_G_1
##
## Value Std.Error   DF   t-value  p-value
## (Intercept)  0.306099 0.3172028 1469   0.964995  0.3347
## Mean_F_G_11  4.761266 0.3308290 1469  -14.391923  0.0000
##
## Correlation:
##             (Intr)
## Mean_F_G_11 0.913
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -3.05245211  -0.69892727  0.01811467  0.69929735  3.02894758
##
## Number of Observations: 1680
## Number of Groups:
## Hospital_F Doctor_F %in% Hospital_F
##        21       210
Model 11 Results

## Linear mixed-effects model fit by REML
## Data: systolic_g
##        AIC      BIC    logLik
##   9829.197 9861.749 -4908.598
##
## Random effects:
## Formula: ~1 | Hospital_F
##   (Intercept)
## StdDev: 0.339177
##
## Formula: ~1 | Doctor_F %in% Hospital_F
##   (Intercept) Residual
## StdDev: 0.0002962927 4.429278
##
## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_1
## Parameter estimates:
##   0   1
## 1.00000 1.024438
##
## Fixed effects: change_systolic ~ Mean_F_G_1
##                Value Std.Error   DF    t value p-value
## (Intercept)  0.306099 0.3144830 1469   0.973341  0.3305
## Mean_F_G_11 -4.712562 0.3273176 1469  -14.397521  0.0000
##
## Correlation:
##              (Intr)
## Mean_F_G_11 -0.908
##
## Standardized Within-Group Residuals:
##                  Min       Q1      Med       Q3       Max
## -3.034153841 -0.701279435 0.009167059 0.693319171 3.054950743
##
## Number of Observations: 1680
## Number of Groups:
##           Hospital_F Doctor_F %in% Hospital_F
##              21                   210
Model 12 Results

## Linear mixed-effects model fit by maximum likelihood
## Data: systolic_g
##  AIC      BIC    logLik
##  9826.564 9859.123 -4907.282
##
## Random effects:
## Formula: ~1 | Hospital_F
##  (Intercept)  StdDev:   0.3123439
##
## Formula: ~1 | Doctor_F %in% Hospital_F
##  (Intercept) Residual  StdDev: 0.0002966376  4.42522
##
## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_1
## Parameter estimates:
## 0 1 1.000000 1.025706
##
## Fixed effects:  change_systolic ~ Mean_F_G_1
##                   Value Std.Error   DF  t-value  p-value
## (Intercept)  0.306099 0.3130697 1469   0.977735  0.3284
## Mean_F_G_1  -4.710059 0.3272415 1469  -14.393219  0.0000
##
## Correlation:
##             (Intr)
## Mean_F_G_1  -0.911
##
## Standardized Within-Group Residuals:
##    Min     Q1    Med    Q3     Max
## -3.022341292 -0.703547675  0.008108789  0.690143342  3.057114859
##
## Number of Observations: 1680
## Number of Groups:
##               Hospital_F Doctor_F %in% Hospital_F
##                        21                   210
Model 13 Results

## Linear mixed-effects model fit by REML
## Data: systolic_g
##    AIC   BIC   logLik
## 9829.826 9867.804 -4907.913

## Random effects:
## Formula: ~1 | Hospital_F
##           (Intercept)
##  StdDev: 0.3427984

## Formula: ~1 | Doctor_F %in% Hospital_F
##           (Intercept) Residual
##  StdDev: 0.0002593762 4.658418

## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_2
## Parameter estimates:
##          0  1  2
## 1.0000000 0.9361625 0.9722146

## Fixed effects: change_systolic ~ Mean_F_G_1
##                 Value Std.Error   DF  t-value p-value
## (Intercept) 0.306099 0.3100978 1469 0.987105 0.3238
## Mean_F_G_11 -4.733408 0.3229824 1469 -14.655314 0.0000

## Correlation:
##             (Intr)
## Mean_F_G_11 -0.904

## Standardized Within-Group Residuals:
##      Min Q1 Med Q3 Max
## -3.03755031 -0.70021263 0.01264186 0.69096616 3.10924631

## Number of Observations: 1680
## Number of Groups:
##                  Hospital_F Doctor_F %in% Hospital_F
## 21 210
Model 14 Results
## Linear mixed-effects model fit by maximum likelihood
## Data: systolic_g
##    AIC      BIC    logLik
## 9827.172 9865.158 -4906.586
##
## Random effects:
## Formula: ~1 | Hospital_F
## (Intercept)
## StdDev:  0.3161544
##
## Formula: ~1 | Doctor_F %in% Hospital_F
## (Intercept) Residual
## StdDev: 0.0002635953 4.655886
##
## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_2
## Parameter estimates:
## 0 1 2
## 1.0000000 0.9357249 0.9730321
## Fixed effects: change_systolic ~ Mean_F_G_1
##                 Value  Std.Error  DF       t-value p-value
## (Intercept)  0.306099 0.3086342 1469  0.991787  0.3215
## Mean_F_G_11 -4.731102 0.3228822 1469 -14.652719  0.0000
## Correlation:
##    (Intr)
## Mean_F_G_11 -0.908
##
## Standardized Within-Group Residuals:
##         Min          Q1         Med          Q3         Max
## -3.02578036 -0.70152243  0.01121081  0.68979562  3.11162255
##
## Number of Observations: 1680
## Number of Groups:
## Hospital_F Doctor_F %in% Hospital_F
## 21 210
Model 15 Results

## Linear mixed-effects model fit by REML
## Data: systolic_g
##   AIC      BIC    logLik
## 9775.293 9818.696 -4879.647

## Random effects:
## Formula: ~1 | Hospital_F
##  (Intercept) StdDev: 0.4481821

## Formula: ~1 | Doctor_F %in% Hospital_F
##  (Intercept) Residual StdDev: 0.0003459471 4.273901

## Variance function:
##  Structure: Different standard deviations per stratum
##  Formula: ~1 | Var_F_G_3

Parameter estimates:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0000000</td>
<td>1.0184239</td>
<td>0.9150174</td>
<td>1.4268349</td>
<td></td>
</tr>
</tbody>
</table>

Fixed effects: change_systolic ~ Mean_F_G_1

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Std.Error</th>
<th>DF</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>0.306099</td>
<td>0.3107204</td>
<td>146</td>
<td>0.985128</td>
<td>0.3247</td>
</tr>
<tr>
<td>Mean_F_G_11</td>
<td>-4.438794</td>
<td>0.3159520</td>
<td>1469</td>
<td>-14.048948</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Correlation:

<table>
<thead>
<tr>
<th></th>
<th>(Intr)</th>
<th>Mean_F_G_11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean_F_G_11</td>
<td>-0.886</td>
<td></td>
</tr>
</tbody>
</table>

Standardized Within-Group Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Q1</th>
<th>Med</th>
<th>Q3</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-3.29229104</td>
<td>-0.74060466</td>
<td>-0.03778026</td>
<td>0.66677221</td>
<td>3.05016798</td>
</tr>
</tbody>
</table>

Number of Observations: 1680

Number of Groups:

| Hospital_F Doctor_F %in% Hospital_F | 21 | 210 |
Model 16 Results

## Linear mixed-effects model fit by maximum likelihood
## Data: systolic_g
##   AIC  BIC logLik
## 9772.763 9816.176 -4878.382

## Random effects:
## Formula: ~1 | Hospital_F
## (Intercept)
## StdDev: 0.4239019

## Formula: ~1 | Doctor_F %in% Hospital_F
## (Intercept) Residual
## StdDev: 0.0003514082 4.267697

## Variance function:
## Structure: Different standard deviations per stratum
## Formula: ~1 | Var_F_G_3
## Parameter estimates:
## 0 1 2 3
## 1.0000000 1.0197313 0.9168706 1.4288039

## Fixed effects: change_systolic ~ Mean_F_G_1
##             Value Std.Error   DF   t value p-value
## (Intercept) 0.306099 0.3088690 1469 0.991032  0.3218
## Mean_F_G_1 -4.437553 0.3157367 1469 -14.054597 0.0000

## Correlation:
##            (Intr)
## Mean_F_G_1 -0.89

## Standardized Within-Group Residuals:
##          Min          Q1         Med          Q3         Max
## -3.29435208 -0.73974381 -0.04173015  0.67041968  3.05010782

## Number of Observations: 1680
## Number of Groups:
## Hospital_F Doctor_F %in% Hospital_F
## 21 210