PubH 7430 – Fall 2005

EXAM

This exam runs from 11:15 am until 12:30 pm. There are 12 questions (5 Application and 7 Concepts) plus 2 extra credit problems.

ANSWER ONLY 10 OF THE 12 QUESTIONS.

Each question is worth 10 points. Please write all your answers in two blue exam books: Application answers in one blue book, and Concepts and Extra Credit answers in another. In all questions, be sure to define any notation you introduce. All questions relate to the following data set.

Data: Development of anemia (low blood levels of red blood cells or hemoglobin) can be a problem for pregnant women. Pregnant women showing possible anemia based on a physician's exam were recruited during month 3 of their pregnancy into a randomized study of a low dose vs. high dose iron supplement. All women gave blood samples at baseline and each month afterwards for five months during their pregnancy. The outcome was serum ferritin (ng/mL). At baseline, information was also collected on whether or not this was the woman's first pregnancy, and whether or not she had a history of anemia.

The researchers would like to know:

A. Do women on the high dose supplement have, on average, higher serum ferritin levels than women on the low dose supplement? If so, by how much?

B. Do women on the high dose supplement have on average a significantly different slope in serum ferritin over the six months than women on the low dose supplement? If so, by how much?

ANSWER ONLY 10 OF THE 12 QUESTIONS.

If you answer more than 10 questions, we will grade the first 10 we find in your blue books.

APPLICATION

A subset of the data are printed on page 5 so you can see how the data are structured. On pages 6–9 you will find some exploratory data analysis summary statistics and plots. On pages 10–19 you will find model output. On page 20 you will find chi-square critical values. On pages 21–23 you will find some diagnostic plots.

1. Using the summary statistics and plots on pages 6–9, briefly describe what the data indicate about:

   (a) research question A, and

   (b) research question B

   shown on page 1.

2. Using the summary statistics and plots on pages 6–9, consider what the data indicate about covariance structures for the two treatment groups.

   (a) Is Toeplitz a reasonable structure to consider? Justify your answer with two reasons why it is or is not reasonable.

   (b) Is AR(1) a reasonable structure to consider? Justify your answer with two reasons why it is or is not reasonable.

3. On pages 10–19 you will find the `PROC MIXED` output from four GLMs for these data. The models are labeled `COVARIANCE MODEL` #1 through `COVARIANCE MODEL` #4. Using these four models, decide whether or not a `GROUP` effect for treatment is needed in the `REPEATED` statement. Justify your answer with formal model comparisons or tests. (You only need to do two comparisons or tests in order to fully answer this question.)

4. Suppose we proceed with `COVARIANCE MODEL` #2. Provide answers to the two questions posed by the researchers on page 1. (Your answers need to be complete sentences which contain more of the statistical results than just significance or lack thereof.)

5. Again suppose we proceed with `COVARIANCE MODEL` #2. Using all the plots and output shown, briefly describe what they indicate about:

   (a) outlying clusters or observations,

   (b) the appropriateness of assuming a linear trend across time, and

   (c) goodness of fit for the variance/covariance structure.

CONCEPTS

6. Suppose you cannot tell whether two covariance structures are nested. Describe how you would decide which of the two structures is preferable.

7. Describe how you would test whether randomization in this study was successful. (Randomization is successful if the difference between the treatment groups at baseline is non-significant.) Be very specific; answers written in SAS code are acceptable.

8. This study had equally spaced time points, one month apart. Suppose the time points were not equally spaced.

   (a) Is Toeplitz still a reasonable structure to consider? Explain your answer.

   (b) Is Unstructured still a reasonable structure to consider? Explain your answer.

9. One woman in the high dose group had serum ferritin levels that decreased substantially across the six visits. (See the right hand plot on page 7.) Describe two things you could do to decide whether or not to keep her observations in the analysis.

10. Consider the two scientific questions of interest shown on page 1. Suppose you were to fit a repeated measures ANOVA model to these data (instead of GLMs). Give two reasons why a repeated measures ANOVA model would be less preferable in answering these questions of interest.

11. We saw that $\hat{\alpha}$ has an approximate normal distribution. Why does this make sense? Answers in words, rather than mathematical derivations, are acceptable. (There are at least two possible answers.)

12. Suppose that instead this was a multi-center randomized trial, and each woman was only followed for two visits rather than six. The outcome would then be serum ferritin at visit 1 minus serum ferritin at baseline. Now we have cluster correlated data: multiple women per clinic, but only one outcome (not longitudinal) observed per woman.

    (a) Name two covariance structures which would be appropriate to analyze these data. (You do not need to justify your answers.)

    (b) For one of your structures, write the SAS code to fit that model. Be sure that both your `MODEL` statement and your `REPEATED` statement are appropriate.

EXTRA CREDIT

1. (2 points) Write down the SAS code which generated `COVARIANCE MODEL` #4.

example data for 4 of the 56 women 1

trt: high dose vs. low dose

anemia: 1=prior anemia vs. 0=no prior anemia

pregnancy: 1=prior pregnancy vs. 0=no prior pregnancy

Obs	id	visit	cvisit	iron	trt	anemia	pregnancy
13	3	0	0	33.9590	low	0	1
14	3	1	1	43.1433	low	0	1
15	3	2	2	38.3521	low	0	1
16	3	3	3	51.6109	low	0	1
17	3	4	4	57.4996	low	0	1
18	3	5	5	60.4470	low	0	1
55	10	0	0	35.7564	high	1	1
56	10	1	1	42.3067	high	1	1
57	10	2	2	38.3743	high	1	1
58	10	3	3	48.0165	high	1	1
59	10	4	4	48.8293	high	1	1
60	10	5	5	56.7787	high	1	1
97	17	0	0	52.5612	high	0	0
98	17	1	1	62.1423	high	0	0
99	17	2	2	61.0941	high	0	0
100	17	3	3	57.6074	high	0	0
101	17	4	4	63.7595	high	0	0
102	17	5	5	64.0540	high	0	0
319	54	0	0	40.7300	low	0	1
320	54	1	1	36.8714	low	0	1
321	54	2	2	39.1645	low	0	1
322	54	3	3	31.1977	low	0	1
323	54	4	4	29.0488	low	0	1
324	54	5	5	31.8504	low	0	1

The SAS System 1

The MEANS Procedure

Analysis Variable : iron

pregnancy	N Obs	N	Mean	Std Dev	Minimum	Maximum
0	102	102	49.2420456	11.9410794	16.0102752	70.3766735
1	234	234	39.5263996	11.7406806	1.4672777	67.9307534

The SAS System 2

The MEANS Procedure

Analysis Variable : iron

anemia	N Obs	N	Mean	Std Dev	Minimum	Maximum
0	252	252	45.0893338	11.9222734	1.4672777	70.3766735
1	84	84	34.6351670	11.3338574	4.8930988	64.0495048

The SAS System 3

The MEANS Procedure

Analysis Variable : iron

trt	N Obs	N	Mean	Std Dev	Minimum	Maximum
high	168	168	45.9579851	12.8198775	4.8930988	70.3766735
low	168	168	38.9935992	11.4001419	1.4672777	64.1443432

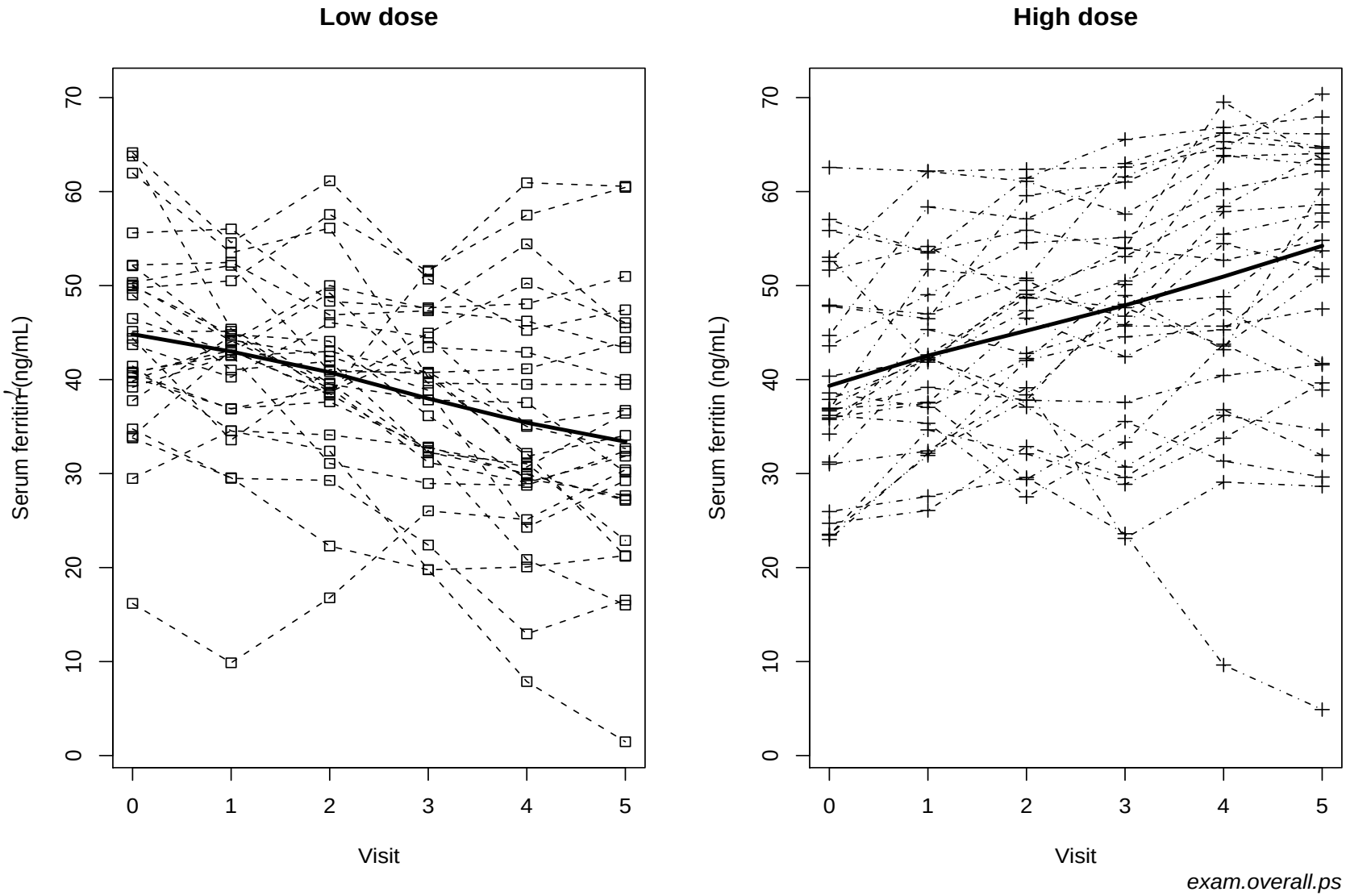
The SAS System 4

The MEANS Procedure

Analysis Variable : iron

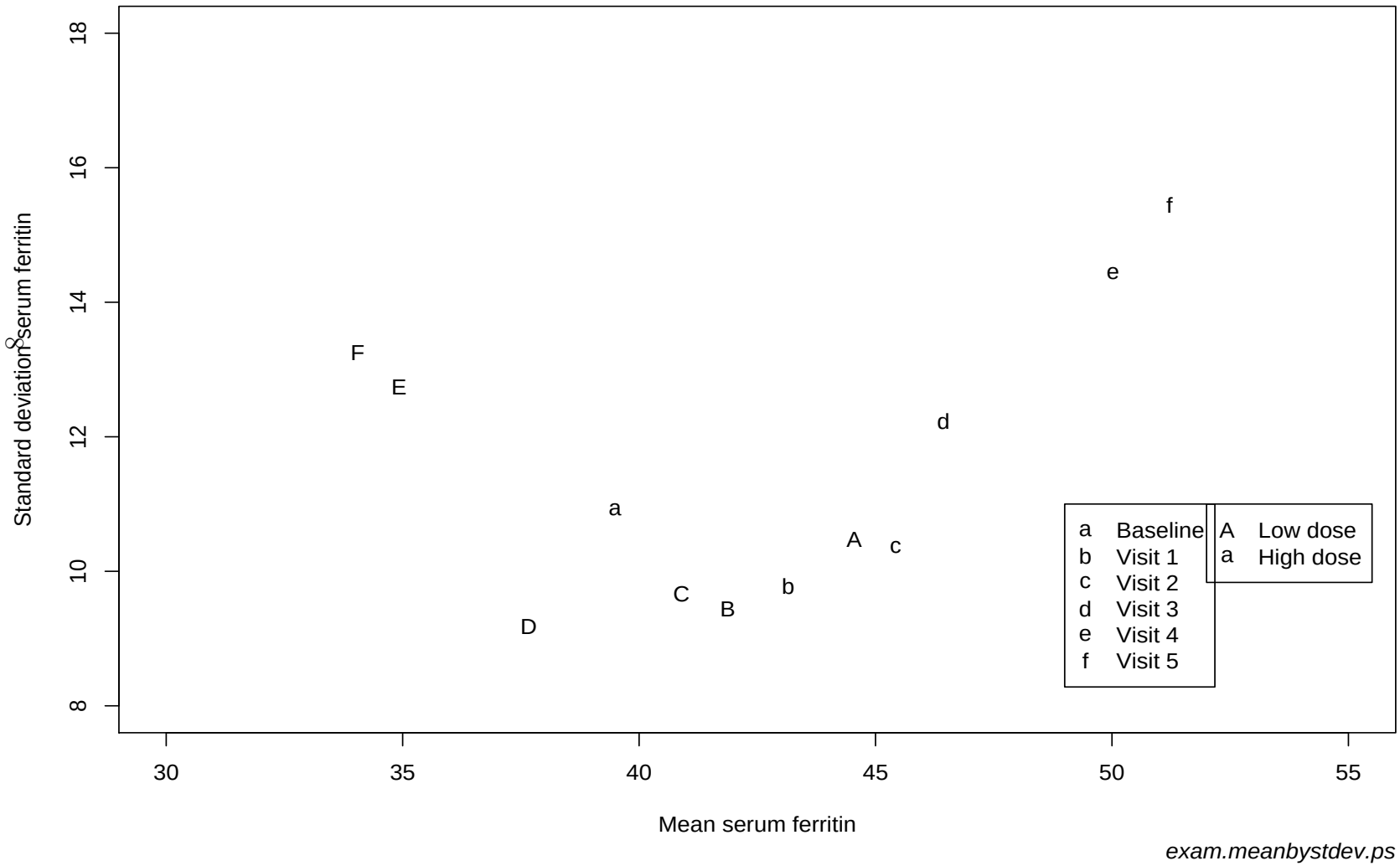
visit	N Obs	N	Mean	Std Dev	Minimum	Maximum
0	56	56	42.0223221	10.9047860	16.1870544	64.1443432
1	56	56	42.5138659	9.5445733	9.8684151	62.1775135
2	56	56	43.1610362	10.1863650	16.7793536	62.3709712
3	56	56	42.0522529	11.5950294	19.7635288	65.5566612
4	56	56	42.4727127	15.4918038	7.8665627	69.5202001
5	56	56	42.6325629	16.6914342	1.4672777	70.3766735

ANEMIA DURING PREGNANCY STUDY



exam.overall.ps

ANEMIA DURING PREGNANCY STUDY



exam.meanbystdev.ps

Correlation matrix of residuals separately by group

Low dose

	lowres0	lowres1	lowres2	lowres3	lowres4	lowres5
lowres0	1.000	0.747	0.674	0.294	0.012	-0.081
lowres1	0.747	1.000	0.757	0.628	0.478	0.353
lowres2	0.674	0.757	1.000	0.736	0.558	0.449
lowres3	0.294	0.628	0.736	1.000	0.895	0.859
lowres4	0.012	0.478	0.558	0.895	1.000	0.931
lowres5	-0.081	0.353	0.449	0.859	0.931	1.000

Variance of residuals by visit:
77.808 63.58 75.562 83.451 153.602 172.688

High dose

	hires0	hires1	hires2	hires3	hires4	hires5
hires0	1.000	0.676	0.657	0.508	0.404	0.381
hires1	0.676	1.000	0.726	0.655	0.526	0.535
hires2	0.657	0.726	1.000	0.783	0.619	0.663
hires3	0.508	0.655	0.783	1.000	0.840	0.891
hires4	0.404	0.526	0.619	0.840	1.000	0.932
hires5	0.381	0.535	0.663	0.891	0.932	1.000

Variance of residuals by visit:
61.026 41.594 68.325 97.333 127.818 172.057

COVARIANCE MODEL # 1 1
trt: high dose vs. low dose
anemia: 1=prior anemia vs. 0=no prior anemia
pregnancy: 1=prior pregnancy vs. 0=no prior pregnancy

The Mixed Procedure

Model Information

Data Set	WORK.DAT
Dependent Variable	iron
Covariance Structure	Toeplitz
Subject Effect	id
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information

Class	Levels	Values
cvisit	6	0 1 2 3 4 5
id	56	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56
trt	2	high low

Dimensions

Covariance Parameters	6
Columns in X	8
Columns in Z	0
Subjects	56
Max Obs Per Subject	6

Number of Observations

Number of Observations Read	336
Number of Observations Used	336
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	2479.20901437	
1	4	2141.28327019	0.00180565
2	1	2140.08085604	0.00008858
3	1	2140.00948738	0.00000061
4	1	2140.00901682	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	122.98	106.63	95.4123	79.9955	58.4271	38.3788
2	106.63	122.98	106.63	95.4123	79.9955	58.4271
3	95.4123	106.63	122.98	106.63	95.4123	79.9955
4	79.9955	95.4123	106.63	122.98	106.63	95.4123
5	58.4271	79.9955	95.4123	106.63	122.98	106.63
6	38.3788	58.4271	79.9955	95.4123	106.63	122.98

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.8670	0.7758	0.6505	0.4751	0.3121
2	0.8670	1.0000	0.8670	0.7758	0.6505	0.4751
3	0.7758	0.8670	1.0000	0.8670	0.7758	0.6505
4	0.6505	0.7758	0.8670	1.0000	0.8670	0.7758
5	0.4751	0.6505	0.7758	0.8670	1.0000	0.8670
6	0.3121	0.4751	0.6505	0.7758	0.8670	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
TOEP(2)	id	106.63
TOEP(3)	id	95.4123
TOEP(4)	id	79.9955
TOEP(5)	id	58.4271
TOEP(6)	id	38.3788
Residual		122.98

Fit Statistics

-2 Res Log Likelihood	2140.0
AIC (smaller is better)	2152.0
AICC (smaller is better)	2152.3
BIC (smaller is better)	2164.2

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
5	339.20	<.0001

Solution for Fixed Effects

Effect	trt	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		52.0852	2.8335	52	18.38	<.0001
anemia		-11.1012	2.8325	52	-3.92	0.0003
pregnancy		-7.5089	2.6490	52	-2.83	0.0065
trt	high	-4.1453	2.9757	52	-1.39	0.1695
trt	low	0	.	.	.	.
visit		-2.1395	0.4902	278	-4.36	<.0001
visit*trt	high	4.4576	0.6932	278	6.43	<.0001
visit*trt	low	0	.	.	.	.

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
anemia	1	52	15.36	0.0003
pregnancy	1	52	8.04	0.0065
trt	1	52	1.94	0.1695
visit	1	278	0.07	0.7970
visit*trt	1	278	41.35	<.0001

Least Squares Means

Effect	trt	Estimate	Standard Error	DF	t Value	Pr > |t|
trt	high	45.7303	1.6887	52	27.08	<.0001
trt	low	38.7318	1.6887	52	22.94	<.0001

Differences of Least Squares Means

Effect	trt	_trt	Estimate	Standard Error	DF	t Value	Pr > |t|
trt	high	low	6.9986	2.4190	52	2.89	0.0056

COVARIANCE MODEL # 2 2

trt: high dose vs. low dose
anemia: 1=prior anemia vs. 0=no prior anemia
pregnancy: 1=prior pregnancy vs. 0=no prior pregnancy

The Mixed Procedure

Model Information

Data Set	WORK.DAT
Dependent Variable	iron
Covariance Structure	Unstructured
Subject Effect	id
Estimation Method	REML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information

Class	Levels	Values
cvisit	6	0 1 2 3 4 5
id	56	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56
trt	2	high low

Dimensions

Covariance Parameters	21
Columns in X	8
Columns in Z	0
Subjects	56
Max Obs Per Subject	6

Number of Observations

Number of Observations Read	336
Number of Observations Used	336
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	2479.20901437	
1	2	2089.18588028	0.00000098
2	1	2089.18514751	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	69.1284	42.9702	46.4241	32.9648	17.7375	16.9889
2	42.9702	52.9107	46.7248	45.5493	43.9787	45.3056
3	46.4241	46.7248	72.3084	62.6362	59.0434	66.0465
4	32.9648	45.5493	62.6362	92.6392	98.0323	114.65

5	17.7375	43.9787	59.0434	98.0323	139.22	148.58
6	16.9889	45.3056	66.0465	114.65	148.58	182.48

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.7105	0.6566	0.4119	0.1808	0.1513
2	0.7105	1.0000	0.7554	0.6506	0.5124	0.4611
3	0.6566	0.7554	1.0000	0.7653	0.5885	0.5750
4	0.4119	0.6506	0.7653	1.0000	0.8632	0.8817
5	0.1808	0.5124	0.5885	0.8632	1.0000	0.9322
6	0.1513	0.4611	0.5750	0.8817	0.9322	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
UN(1,1)	id	69.1284
UN(2,1)	id	42.9702
UN(2,2)	id	52.9107
UN(3,1)	id	46.4241
UN(3,2)	id	46.7248
UN(3,3)	id	72.3084
UN(4,1)	id	32.9648
UN(4,2)	id	45.5493
UN(4,3)	id	62.6362
UN(4,4)	id	92.6392
UN(5,1)	id	17.7375
UN(5,2)	id	43.9787
UN(5,3)	id	59.0434
UN(5,4)	id	98.0323
UN(5,5)	id	139.22
UN(6,1)	id	16.9889
UN(6,2)	id	45.3056
UN(6,3)	id	66.0465
UN(6,4)	id	114.65
UN(6,5)	id	148.58
UN(6,6)	id	182.48

Fit Statistics

-2 Res Log Likelihood	2089.2
AIC (smaller is better)	2131.2
AICC (smaller is better)	2134.2
BIC (smaller is better)	2173.7

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
20	390.02	<.0001

Solution for Fixed Effects

Effect	trt	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		51.1297	2.0810	52	24.57	<.0001
anemia		-11.8869	2.2290	52	-5.33	<.0001
pregnancy		-7.1136	2.0845	52	-3.41	0.0013
trt	high	-2.3525	2.0495	52	-1.15	0.2563
trt	low	0	.	.	.	.
visit		-1.8032	0.5245	52	-3.44	0.0012
visit*trt	high	4.1687	0.7418	52	5.62	<.0001
visit*trt	low	0	.	.	.	.

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F

```
anemia          1      52      28.44    <.0001
pregnancy       1      52      11.65    0.0013
trt             1      52       1.32    0.2563
visit           1      52       0.57    0.4519
visit*trt       1      52      31.58    <.0001


                        Least Squares Means

                                 Standard
Effect    trt     Estimate       Error      DF    t Value    Pr > |t|

trt       high     46.7650      1.5380      52      30.41      <.0001
trt       low      38.6958      1.5380      52      25.16      <.0001


                    Differences of Least Squares Means

                                       Standard
Effect    trt     _trt    Estimate       Error      DF    t Value    Pr > |t|

trt       high    low       8.0693      2.1961      52       3.67      0.0006

================================================================================================================================================

COVARIANCE MODEL # 3                                                                                                                        3
trt: high dose vs. low dose
anemia: 1=prior anemia vs. 0=no prior anemia
pregnancy: 1=prior pregnancy vs. 0=no prior pregnancy

The Mixed Procedure

                  Model Information

Data Set                     WORK.DAT
Dependent Variable           iron
Covariance Structure         Toeplitz
Subject Effect               id
Group Effect                 trt
Estimation Method            REML
Residual Variance Method     None
Fixed Effects SE Method      Model-Based
Degrees of Freedom Method    Between-Within


             Class Level Information

Class     Levels    Values

cvisit         6    0 1 2 3 4 5
id            56    1 2 3 4 5 6 7 8 9 10 11 12 13
                    14 15 16 17 18 19 20 21 22 23
                    24 25 26 27 28 29 30 31 32 33
                    34 35 36 37 38 39 40 41 42 43
                    44 45 46 47 48 49 50 51 52 53
                    54 55 56
trt            2    high low


            Dimensions

Covariance Parameters            12
Columns in X                      8
Columns in Z                      0
Subjects                         56
Max Obs Per Subject               6


          Number of Observations

Number of Observations Read             336
Number of Observations Used             336
Number of Observations Not Used           0


                     Iteration History
```

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	2479.20901437	
1	3	2143.72655395	0.01796164
2	2	2135.29086431	0.00190990
3	1	2133.59424376	0.00023088
4	1	2133.39834268	0.00000936
5	1	2133.39097028	0.00000002
6	1	2133.39095309	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	134.82	119.23	105.68	86.5829	58.1924	31.2019
2	119.23	134.82	119.23	105.68	86.5829	58.1924
3	105.68	119.23	134.82	119.23	105.68	86.5829
4	86.5829	105.68	119.23	134.82	119.23	105.68
5	58.1924	86.5829	105.68	119.23	134.82	119.23
6	31.2019	58.1924	86.5829	105.68	119.23	134.82

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.8844	0.7838	0.6422	0.4316	0.2314
2	0.8844	1.0000	0.8844	0.7838	0.6422	0.4316
3	0.7838	0.8844	1.0000	0.8844	0.7838	0.6422
4	0.6422	0.7838	0.8844	1.0000	0.8844	0.7838
5	0.4316	0.6422	0.7838	0.8844	1.0000	0.8844
6	0.2314	0.4316	0.6422	0.7838	0.8844	1.0000

Estimated R Matrix for id 4

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	111.48	94.5728	85.7744	74.3831	60.1870	47.2501
2	94.5728	111.48	94.5728	85.7744	74.3831	60.1870
3	85.7744	94.5728	111.48	94.5728	85.7744	74.3831
4	74.3831	85.7744	94.5728	111.48	94.5728	85.7744
5	60.1870	74.3831	85.7744	94.5728	111.48	94.5728
6	47.2501	60.1870	74.3831	85.7744	94.5728	111.48

Estimated R Correlation Matrix for id 4

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.8483	0.7694	0.6672	0.5399	0.4238
2	0.8483	1.0000	0.8483	0.7694	0.6672	0.5399
3	0.7694	0.8483	1.0000	0.8483	0.7694	0.6672
4	0.6672	0.7694	0.8483	1.0000	0.8483	0.7694
5	0.5399	0.6672	0.7694	0.8483	1.0000	0.8483
6	0.4238	0.5399	0.6672	0.7694	0.8483	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Group	Estimate
Variance	id	trt high	111.48
TOEP(2)	id	trt high	94.5728
TOEP(3)	id	trt high	85.7744
TOEP(4)	id	trt high	74.3831
TOEP(5)	id	trt high	60.1870
TOEP(6)	id	trt high	47.2501
Variance	id	trt low	134.82
TOEP(2)	id	trt low	119.23
TOEP(3)	id	trt low	105.68
TOEP(4)	id	trt low	86.5829

```
TOEP(5)      id         trt low      58.1924
TOEP(6)      id         trt low      31.2019


          Fit Statistics

-2 Res Log Likelihood          2133.4
AIC (smaller is better)        2157.4
AICC (smaller is better)       2158.4
BIC (smaller is better)        2181.7


  Null Model Likelihood Ratio Test

    DF    Chi-Square      Pr > ChiSq

    11        345.82          <.0001


                     Solution for Fixed Effects

                                 Standard
Effect       trt     Estimate       Error      DF    t Value    Pr > |t|

Intercept             51.9525      2.8486      52      18.24      <.0001
anemia               -10.8547      2.8020      52      -3.87      0.0003
pregnancy             -7.3999      2.6156      52      -2.83      0.0066
trt          high     -3.9771      2.9464      52      -1.35      0.1829
trt          low           0           .       .         .         .
visit                 -2.1376      0.5434     278      -3.93      0.0001
visit*trt    high      4.4603      0.6900     278       6.46      <.0001
visit*trt    low            0           .       .         .         .


        Type 3 Tests of Fixed Effects

              Num     Den
Effect         DF      DF    F Value    Pr > F

anemia          1      52      15.01    0.0003
pregnancy       1      52       8.00    0.0066
trt             1      52       1.82    0.1829
visit           1     278       0.07    0.7886
visit*trt       1     278      41.79    <.0001


                        Least Squares Means

                            Standard
Effect    trt     Estimate       Error      DF    t Value    Pr > |t|

trt       high     45.9151      1.6992      52      27.02      <.0001
trt       low      38.7414      1.6354      52      23.69      <.0001


                    Differences of Least Squares Means

                                       Standard
Effect    trt     _trt    Estimate       Error      DF    t Value    Pr > |t|

trt       high    low       7.1736      2.3887      52       3.00      0.0041

================================================================================================================================

COVARIANCE MODEL # 4                                                                                                        4
trt: high dose vs. low dose
anemia: 1=prior anemia vs. 0=no prior anemia
pregnancy: 1=prior pregnancy vs. 0=no prior pregnancy

The Mixed Procedure

                 Model Information

Data Set                     WORK.DAT
Dependent Variable           iron
Covariance Structure         Unstructured
Subject Effect               id
```

Group Effect	trt
Estimation Method	REML
Residual Variance Method	None
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Between-Within

Class Level Information

Class	Levels	Values
cvisit	6	0 1 2 3 4 5
id	56	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56
trt	2	high low

Dimensions

Covariance Parameters	42
Columns in X	8
Columns in Z	0
Subjects	56
Max Obs Per Subject	6

Number of Observations

Number of Observations Read	336
Number of Observations Used	336
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	2479.20901437	
1	2	2066.29940002	0.00001453
2	1	2066.28853263	0.00000002
3	1	2066.28851452	0.00000000

Convergence criteria met.

Estimated R Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	75.5801	49.7535	50.5653	23.4575	0.4872	-8.1722
2	49.7535	60.7618	52.0188	47.0929	49.4422	42.2625
3	50.5653	52.0188	75.2989	60.3797	62.0462	57.4405
4	23.4575	47.0929	60.3797	87.8384	107.43	111.64
5	0.4872	49.4422	62.0462	107.43	161.97	164.46
6	-8.1722	42.2625	57.4405	111.64	164.46	188.48

Estimated R Correlation Matrix for id 1

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.7342	0.6703	0.2879	0.004403	-0.06847
2	0.7342	1.0000	0.7690	0.6446	0.4984	0.3949
3	0.6703	0.7690	1.0000	0.7424	0.5618	0.4822
4	0.2879	0.6446	0.7424	1.0000	0.9006	0.8677
5	0.004403	0.4984	0.5618	0.9006	1.0000	0.9412
6	-0.06847	0.3949	0.4822	0.8677	0.9412	1.0000

Estimated R Matrix for id 4

Row	Col1	Col2	Col3	Col4	Col5	Col6

1	63.1346	36.1506	42.1607	43.3094	35.0522	43.1209
2	36.1506	44.5564	40.7106	44.7665	38.5551	49.2964
3	42.1607	40.7106	68.0908	65.5094	55.8300	75.1922
4	43.3094	44.7665	65.5094	100.92	91.8326	122.09
5	35.0522	38.5551	55.8300	91.8326	119.46	136.98
6	43.1209	49.2964	75.1922	122.09	136.98	182.00

Estimated R Correlation Matrix for id 4

Row	Col1	Col2	Col3	Col4	Col5	Col6
1	1.0000	0.6816	0.6430	0.5426	0.4036	0.4023
2	0.6816	1.0000	0.7391	0.6676	0.5285	0.5474
3	0.6430	0.7391	1.0000	0.7903	0.6190	0.6754
4	0.5426	0.6676	0.7903	1.0000	0.8364	0.9008
5	0.4036	0.5285	0.6190	0.8364	1.0000	0.9290
6	0.4023	0.5474	0.6754	0.9008	0.9290	1.0000

Covariance Parameter Estimates

Cov Parm	Subject	Group	Estimate
UN(1,1)	id	trt high	63.1346
UN(2,1)	id	trt high	36.1506
UN(2,2)	id	trt high	44.5564
UN(3,1)	id	trt high	42.1607
UN(3,2)	id	trt high	40.7106
UN(3,3)	id	trt high	68.0908
UN(4,1)	id	trt high	43.3094
UN(4,2)	id	trt high	44.7665
UN(4,3)	id	trt high	65.5094
UN(4,4)	id	trt high	100.92
UN(5,1)	id	trt high	35.0522
UN(5,2)	id	trt high	38.5551
UN(5,3)	id	trt high	55.8300
UN(5,4)	id	trt high	91.8326
UN(5,5)	id	trt high	119.46
UN(6,1)	id	trt high	43.1209
UN(6,2)	id	trt high	49.2964
UN(6,3)	id	trt high	75.1922
UN(6,4)	id	trt high	122.09
UN(6,5)	id	trt high	136.98
UN(6,6)	id	trt high	182.00
UN(1,1)	id	trt low	75.5801
UN(2,1)	id	trt low	49.7535
UN(2,2)	id	trt low	60.7618
UN(3,1)	id	trt low	50.5653
UN(3,2)	id	trt low	52.0188
UN(3,3)	id	trt low	75.2989
UN(4,1)	id	trt low	23.4575
UN(4,2)	id	trt low	47.0929
UN(4,3)	id	trt low	60.3797
UN(4,4)	id	trt low	87.8384
UN(5,1)	id	trt low	0.4872
UN(5,2)	id	trt low	49.4422
UN(5,3)	id	trt low	62.0462
UN(5,4)	id	trt low	107.43
UN(5,5)	id	trt low	161.97
UN(6,1)	id	trt low	-8.1722
UN(6,2)	id	trt low	42.2625
UN(6,3)	id	trt low	57.4405
UN(6,4)	id	trt low	111.64
UN(6,5)	id	trt low	164.46
UN(6,6)	id	trt low	188.48

Fit Statistics

-2 Res Log Likelihood	2066.3
AIC (smaller is better)	2150.3
AICC (smaller is better)	2162.9
BIC (smaller is better)	2235.4

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
41	412.92	<.0001

Solution for Fixed Effects

Effect	trt	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		50.9050	2.0880	52	24.38	<.0001
anemia		-12.1845	2.0826	52	-5.85	<.0001
pregnancy		-6.8341	1.9601	52	-3.49	0.0010
trt	high	-1.6468	1.9868	52	-0.83	0.4110
trt	low	0	.	.	.	.
visit		-1.5933	0.5512	278	-2.89	0.0042
visit*trt	high	4.1014	0.7183	278	5.71	<.0001
visit*trt	low	0	.	.	.	.

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
anemia	1	52	34.23	<.0001
pregnancy	1	52	12.16	0.0010
trt	1	52	0.69	0.4110
visit	1	278	1.62	0.2039
visit*trt	1	278	32.60	<.0001

Least Squares Means

Effect	trt	Estimate	Standard Error	DF	t Value	Pr > |t|
trt	high	47.7229	1.4315	52	33.34	<.0001
trt	low	39.1162	1.4858	52	26.33	<.0001

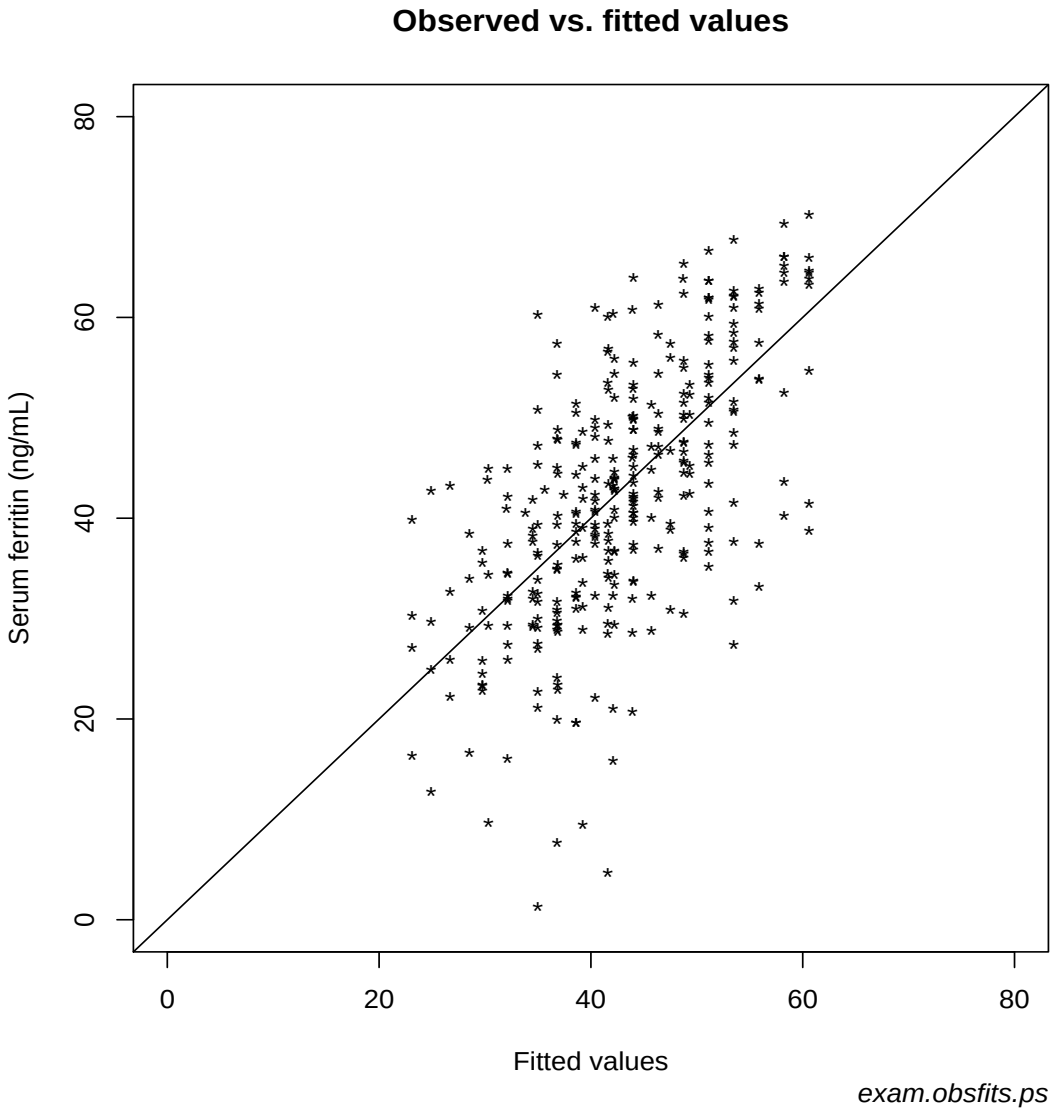
Differences of Least Squares Means

Effect	trt	_trt	Estimate	Standard Error	DF	t Value	Pr > |t|
trt	high	low	8.6066	2.0829	52	4.13	0.0001

0.95 quantile cut-points for hypothesis tests using $\alpha = 0.05$ for χ^2 distributions:

Distribution	Quantile cut-point
$\frac{1}{2}\chi^2_0 + \frac{1}{2}\chi^2_1$	2.72
$\frac{1}{2}\chi^2_1 + \frac{1}{2}\chi^2_2$	5.14
χ^2_1	3.84
χ^2_2	5.99
χ^2_3	7.81
χ^2_4	9.49
χ^2_5	11.07
χ^2_6	12.59
χ^2_7	14.07
χ^2_8	15.51
χ^2_9	16.92
χ^2_{10}	18.31
χ^2_{11}	19.68
χ^2_{12}	21.03
χ^2_{13}	22.36
χ^2_{14}	23.68
χ^2_{15}	25.00
χ^2_{16}	26.30
χ^2_{17}	27.59
χ^2_{18}	28.87
χ^2_{19}	30.14
χ^2_{20}	31.41
χ^2_{21}	32.67
χ^2_{22}	33.92
χ^2_{23}	35.17
χ^2_{24}	36.42
χ^2_{25}	37.65

You do not need to compute p-values for any likelihood ratio tests you report; just report whether or not they are significant at level $\alpha = 0.05$. I have not given you sufficient tables to compute a p-value.



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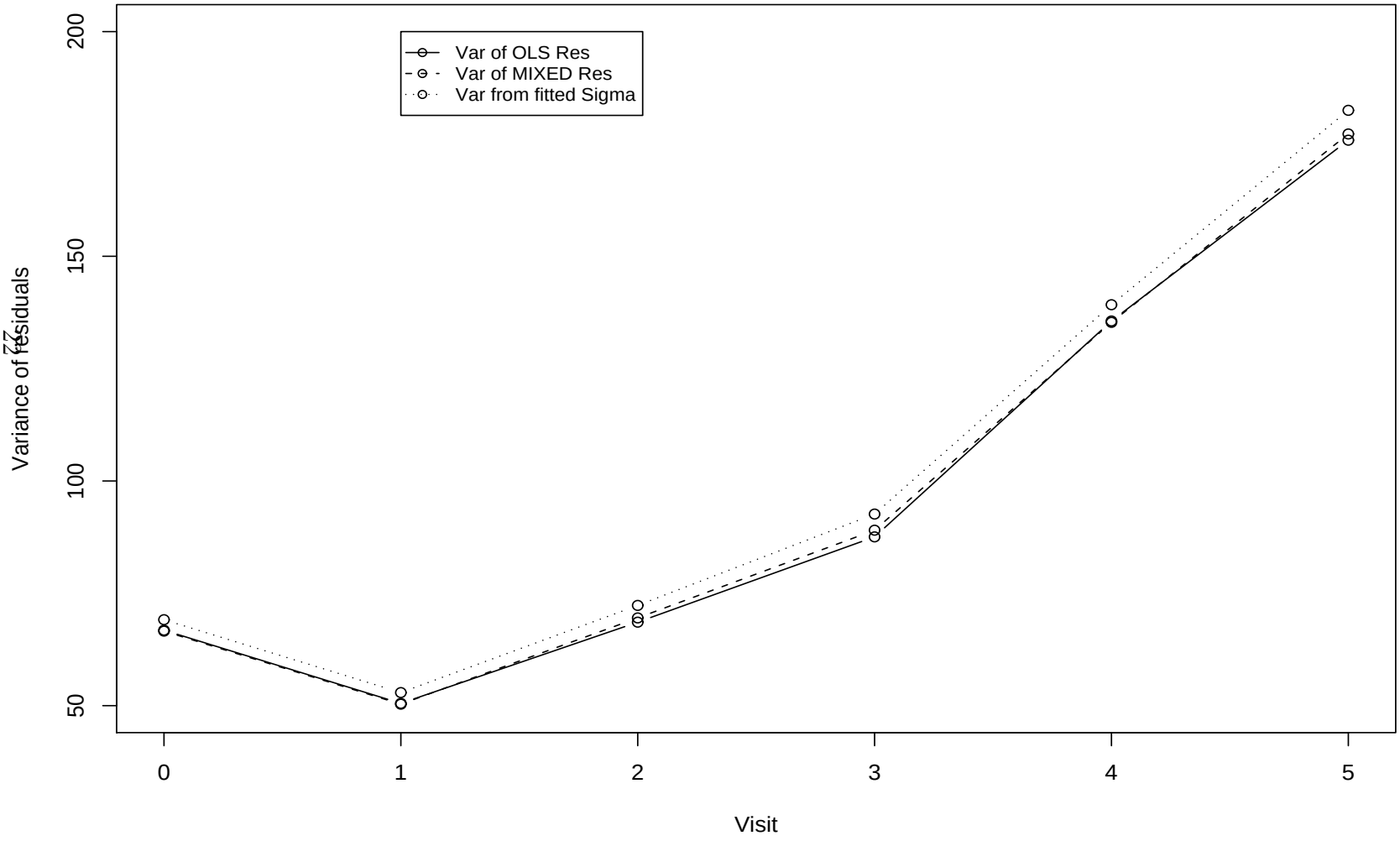
ANEMIA DURING PREGNANCY STUDY

Variances of OLS and MIXED residuals compared to fitted variances from Sigma−hat



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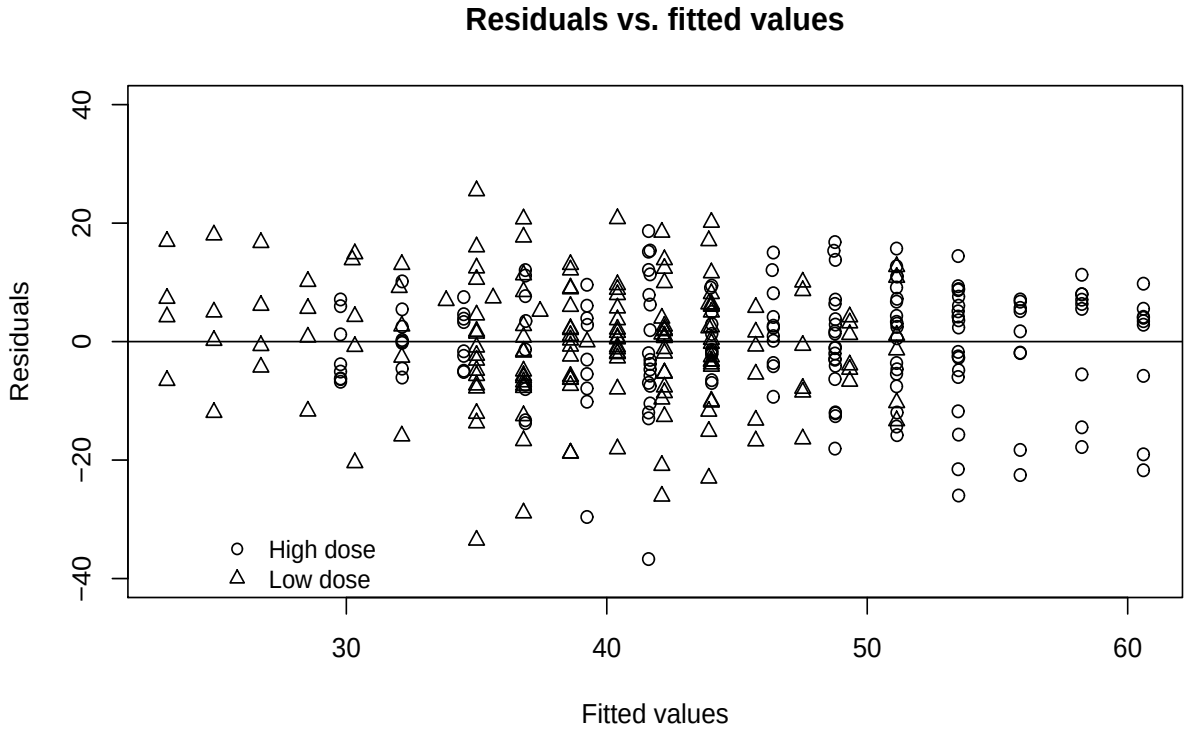

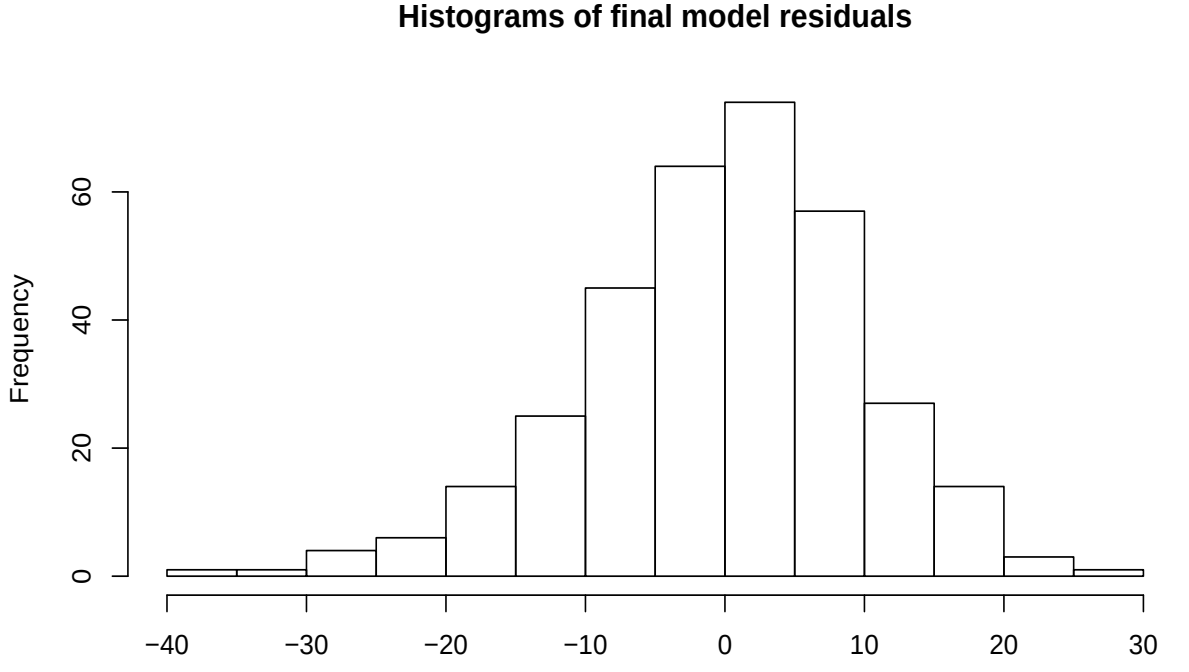

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