* In the Framingham study, each of 2634 participants was examined every 2

years for a 10 year period for his/her cholesterol level.

* Study objectives:
  + How does cholesterol level change over time on average as people get older?
  + How is the change of cholesterol level associated with sex and baseline age?
* A subset of 200 subjects' data is used for illustrative purpose.
* Below is the spaghetti plot of the 200 subjects.

****

**data** cholst;

input ID cholst sex age time;

datalines;

1 175 1 32 0

1 198 1 32 2

200 252 0 46 10

;

**run**;

**proc** **mixed** data=cholst;

class ID;

model cholst = / s;

random intercept/subject=ID g gcorr v vcorr;

**run**;

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.CHOLST |
| **Dependent Variable** | cholst |
| **Covariance Structure** | Unstructured |
| **Subject Effect** | ID |
| **Estimation Method** | REML |
| **Residual Variance Method** | Profile |
| **Fixed Effects SE Method** | Model-Based |
| **Degrees of Freedom Method** | Containment |

| **Dimensions** | |
| --- | --- |
| **Covariance Parameters** | 2 |
| **Columns in X** | 1 |
| **Columns in Z per Subject** | 1 |
| **Subjects** | 200 |
| **Max Obs per Subject** | 6 |

| **Iteration History** | | | |
| --- | --- | --- | --- |
| **Iteration** | **Evaluations** | **-2 Res Log Like** | **Criterion** |
| **0** | 1 | 10813.99587154 |  |
| **1** | 2 | 9925.13211020 | 0.00000001 |
| **2** | 1 | 9925.13205318 | 0.00000000 |

| **Estimated G Matrix** | | | |
| --- | --- | --- | --- |
| **Row** | **Effect** | **ID** | **Col1** |
| **1** | Intercept | 1 | 1394.48 |

| **Estimated G Correlation Matrix** | | | |
| --- | --- | --- | --- |
| **Row** | **Effect** | **ID** | **Col1** |
| **1** | Intercept | 1 | 1.0000 |

| **Estimated V Matrix for ID 1** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Row** | **Col1** | **Col2** | **Col3** | **Col4** | **Col5** | **Col6** |
| **1** | 1862.71 | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1394.48 |
| **2** | 1394.48 | 1862.71 | 1394.48 | 1394.48 | 1394.48 | 1394.48 |
| **3** | 1394.48 | 1394.48 | 1862.71 | 1394.48 | 1394.48 | 1394.48 |
| **4** | 1394.48 | 1394.48 | 1394.48 | 1862.71 | 1394.48 | 1394.48 |
| **5** | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1862.71 | 1394.48 |
| **6** | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1862.71 |

| **Estimated V Correlation Matrix for ID 1** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Row** | **Col1** | **Col2** | **Col3** | **Col4** | **Col5** | **Col6** |
| **1** | 1.0000 | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 0.7486 |
| **2** | 0.7486 | 1.0000 | 0.7486 | 0.7486 | 0.7486 | 0.7486 |
| **3** | 0.7486 | 0.7486 | 1.0000 | 0.7486 | 0.7486 | 0.7486 |
| **4** | 0.7486 | 0.7486 | 0.7486 | 1.0000 | 0.7486 | 0.7486 |
| **5** | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 1.0000 | 0.7486 |
| **6** | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 1.0000 |

| **Covariance Parameter Estimates** | | |
| --- | --- | --- |
| **Cov Parm** | **Subject** | **Estimate** |
| **UN(1,1)** | ID | 1394.48 |
| **Residual** |  | 468.23 |

| **Fit Statistics** | |
| --- | --- |
| **-2 Res Log Likelihood** | 9925.1 |
| **AIC (Smaller is Better)** | 9929.1 |
| **AICC (Smaller is Better)** | 9929.1 |
| **BIC (Smaller is Better)** | 9935.7 |

| **Solution for Fixed Effects** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Effect** | **Estimate** | **Standard Error** | **DF** | **t Value** | **Pr > |t|** |
| **Intercept** | 138.47 | 15.9220 | 197 | 8.70 | <.0001 |

Now let’s do the same analysis using a compound symmetric covariance matrix.

**proc** **mixed** data=cholst;

class ID;

model cholst = / s;

repeated /type=CS subject=ID r rcorr;

**run**;

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.CHOLST |
| **Dependent Variable** | cholst |
| **Covariance Structure** | Compound Symmetry |
| **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** |
| **ID** | 200 | 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 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 |

| **Dimensions** | |
| --- | --- |
| **Covariance Parameters** | 2 |
| **Columns in X** | 1 |
| **Columns in Z** | 0 |
| **Subjects** | 200 |
| **Max Obs per Subject** | 6 |

| **Number of Observations** | |
| --- | --- |
| **Number of Observations Read** | 1044 |
| **Number of Observations Used** | 1044 |
| **Number of Observations Not Used** | 0 |

| **Iteration History** | | | |
| --- | --- | --- | --- |
| **Iteration** | **Evaluations** | **-2 Res Log Like** | **Criterion** |
| **0** | 1 | 10813.99587154 |  |
| **1** | 2 | 9925.13211020 | 0.00000001 |
| **2** | 1 | 9925.13205318 | 0.00000000 |

| **Estimated R Matrix for ID 1** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Row** | **Col1** | **Col2** | **Col3** | **Col4** | **Col5** | **Col6** |
| **1** | 1862.71 | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1394.48 |
| **2** | 1394.48 | 1862.71 | 1394.48 | 1394.48 | 1394.48 | 1394.48 |
| **3** | 1394.48 | 1394.48 | 1862.71 | 1394.48 | 1394.48 | 1394.48 |
| **4** | 1394.48 | 1394.48 | 1394.48 | 1862.71 | 1394.48 | 1394.48 |
| **5** | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1862.71 | 1394.48 |
| **6** | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1394.48 | 1862.71 |

| **Estimated R Correlation Matrix for ID 1** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Row** | **Col1** | **Col2** | **Col3** | **Col4** | **Col5** | **Col6** |
| **1** | 1.0000 | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 0.7486 |
| **2** | 0.7486 | 1.0000 | 0.7486 | 0.7486 | 0.7486 | 0.7486 |
| **3** | 0.7486 | 0.7486 | 1.0000 | 0.7486 | 0.7486 | 0.7486 |
| **4** | 0.7486 | 0.7486 | 0.7486 | 1.0000 | 0.7486 | 0.7486 |
| **5** | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 1.0000 | 0.7486 |
| **6** | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 0.7486 | 1.0000 |

| **Covariance Parameter Estimates** | | |
| --- | --- | --- |
| **Cov Parm** | **Subject** | **Estimate** |
| **CS** | ID | 1394.48 |
| **Residual** |  | 468.23 |

| **Fit Statistics** | |
| --- | --- |
| **-2 Res Log Likelihood** | 9925.1 |
| **AIC (Smaller is Better)** | 9929.1 |
| **AICC (Smaller is Better)** | 9929.1 |
| **BIC (Smaller is Better)** | 9935.7 |

| **Solution for Fixed Effects** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Effect** | **Estimate** | **Standard Error** | **DF** | **t Value** | **Pr > |t|** |
| **Intercept** | 138.47 | 15.9220 | 197 | 8.70 | <.0001 |

As we can see the compound symmetry analysis is equivalent to the random intercept model.