data air\_pol;

input ID Height Age INI\_Height INI\_Age Log\_FEV1;

L\_Height = log(Height);

L\_INI\_Height = log(INI\_Height);

L\_Age = log(Age);

L\_INI\_Age = log(INI\_Age);

datalines;

1 1.20 9.3415 1.20 9.3415 0.21511

………..

300 1.63 17.8645 1.44 11.9617 1.16938

;

run;

\*Start with the fixed effect analysis. This analysis is greatly simplified using the absorb term;

**proc glm data=air\_pol;**

**absorb ID;**

**model Log\_FEV1 = L\_Age Height/solution;**

**run;**

**quit;**

**The GLM Procedure**

**Dependent Variable: Log\_FEV1**

| **Source** | **DF** | **Sum of Squares** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **Model** | 300 | 208.6461864 | 0.6954873 | 172.21 | <.0001 |
| **Error** | 1692 | 6.8333959 | 0.0040387 |  |  |
| **Corrected Total** | 1992 | 215.4795823 |  |  |  |

| **R-Square** | **Coeff Var** | **Root MSE** | **Log\_FEV1 Mean** |
| --- | --- | --- | --- |
| 0.968288 | 7.788000 | 0.063550 | 0.816004 |

| **Source** | **DF** | **Type I SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **ID** | 298 | 65.0614168 | 0.2183269 | 54.06 | <.0001 |
| **L\_Age** | 1 | 138.3949317 | 138.3949317 | 34267.6 | <.0001 |
| **Height** | 1 | 5.1898380 | 5.1898380 | 1285.04 | <.0001 |

| **Source** | **DF** | **Type III SS** | **Mean Square** | **F Value** | **Pr > F** |
| --- | --- | --- | --- | --- | --- |
| **L\_Age** | 1 | 0.86651269 | 0.86651269 | 214.56 | <.0001 |
| **Height** | 1 | 5.18983798 | 5.18983798 | 1285.04 | <.0001 |

| **Parameter** | **Estimate** | **Standard Error** | **t Value** | **Pr > |t|** |
| --- | --- | --- | --- | --- |
| **L\_Age** | 0.311246221 | 0.02124882 | 14.65 | <.0001 |
| **Height** | 1.467778605 | 0.04094508 | 35.85 | <.0001 |

Proc mixed data = air\_pol;

class ID;

model Log\_FEV1 = INI\_Height Height L\_INI\_Age L\_Age/ solution;

random intercept /type=UN subject=ID g gcorr v vcorr;

run;

| **Solution for Fixed Effects** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Effect** | **Estimate** | **Standard Error** | **DF** | **t Value** | **Pr > |t|** |
| **Intercept** | -2.1339 | 0.08428 | 297 | -25.32 | <.0001 |
| **Height** | 1.4506 | 0.04039 | 1691 | 35.91 | <.0001 |
| **L\_Age** | 0.3192 | 0.02098 | 1691 | 15.21 | <.0001 |

**\*Now we'll center the covariates and fit them to a longitudinal and cross sectional model;**

**proc** **means** data=air\_pol\_trans nway;

class id;

var age;

output out=two mean=mage;

**run**;

| **Analysis Variable : Age** | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **ID** | **N Obs** | **N** | **Mean** | **Std Dev** | **Minimum** | **Maximum** |
| 1 | 7 | 7 | 12.7016571 | 2.5792330 | 9.3415000 | 16.3723000 |
| 2 | 8 | 8 | 13.1957500 | 4.0681923 | 6.5873000 | 17.6318000 |
| 3 | 9 | 9 | 11.4652222 | 3.2554368 | 6.9131000 | 16.0164000 |
| 299 | 6 | 6 | 15.4528833 | 1.8728064 | 12.9555000 | 17.9904000 |
| 300 | 7 | 7 | 14.9482714 | 2.1421772 | 11.9617000 | 17.8645000 |

**proc** **sort** data=air\_pol\_trans;

by ID;

**proc** **sort** data=two;

by ID;

**data** three;

merge air\_pol\_trans two;

by ID;

cage = age - mage;

**run**;

**\*We'll analyze a version of the outcome that has already been corrected for height;**

**proc** **mixed** data = three;

class ID;

model Log\_FEV1\_HT = cage mage/ solution;

random intercept /subject=ID g;

contrast 'Longitudinal vs. Cross sectional' cage **1** mage -**1**;

**run**;

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.THREE |
| **Dependent Variable** | Log\_FEV1\_HT |
| **Covariance Structure** | Variance Components |
| **Subject Effect** | ID |
| **Estimation Method** | REML |
| **Residual Variance Method** | Profile |
| **Fixed Effects SE Method** | Model-Based |
| **Degrees of Freedom Method** | Containment |

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **ID** | 299 | 1 2 3 4 5 ……………….300 |

| **Dimensions** | |
| --- | --- |
| **Covariance Parameters** | 2 |
| **Columns in X** | 3 |
| **Columns in Z per Subject** | 1 |
| **Subjects** | 299 |
| **Max Obs per Subject** | 12 |

| **Number of Observations** | |
| --- | --- |
| **Number of Observations Read** | 1993 |
| **Number of Observations Used** | 1993 |
| **Number of Observations Not Used** | 0 |

| **Iteration History** | | | |
| --- | --- | --- | --- |
| **Iteration** | **Evaluations** | **-2 Res Log Like** | **Criterion** |
| **0** | 1 | -2921.88193214 |  |
| **1** | 2 | -4468.05875634 | 0.00001361 |
| **2** | 1 | -4468.11540864 | 0.00000002 |
| **3** | 1 | -4468.11549096 | 0.00000000 |

| **Covariance Parameter Estimates** | | |
| --- | --- | --- |
| **Cov Parm** | **Subject** | **Estimate** |
| **Intercept** | ID | 0.009336 |
| **Residual** |  | 0.004190 |

| **Fit Statistics** | |
| --- | --- |
| **-2 Res Log Likelihood** | -4468.1 |
| **AIC (Smaller is Better)** | -4464.1 |
| **AICC (Smaller is Better)** | -4464.1 |
| **BIC (Smaller is Better)** | -4456.7 |

| **Solution for Fixed Effects** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Effect** | **Estimate** | **Standard Error** | **DF** | **t Value** | **Pr > |t|** |
| **Intercept** | -0.3483 | 0.03517 | 297 | -9.90 | <.0001 |
| **cage** | 0.02982 | 0.000480 | 1693 | 62.18 | <.0001 |
| **mage** | 0.02923 | 0.002901 | 1693 | 10.08 | <.0001 |

| **Type 3 Tests of Fixed Effects** | | | | |
| --- | --- | --- | --- | --- |
| **Effect** | **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| **cage** | 1 | 1693 | 3865.92 | <.0001 |
| **mage** | 1 | 1693 | 101.52 | <.0001 |

| **Contrasts** | | | | |
| --- | --- | --- | --- | --- |
| **Label** | **Num DF** | **Den DF** | **F Value** | **Pr > F** |
| Longitudinal vs. Cross sectional | 1 | 1693 | 0.04 | 0.8413 |

**Now we’ll refit the model with a single covariate:**

**proc** **mixed** data = three;

class ID;

model Log\_FEV1\_HT = age/ solution;

random intercept /subject=ID g;

**run**;

| **Model Information** | |
| --- | --- |
| **Data Set** | WORK.THREE |
| **Dependent Variable** | Log\_FEV1\_HT |
| **Covariance Structure** | Variance Components |
| **Subject Effect** | ID |
| **Estimation Method** | REML |
| **Residual Variance Method** | Profile |
| **Fixed Effects SE Method** | Model-Based |
| **Degrees of Freedom Method** | Containment |

| **Class Level Information** | | |
| --- | --- | --- |
| **Class** | **Levels** | **Values** |
| **ID** | 299 | 1 2 3 4 …………. 300 |

| **Fit Statistics** | |
| --- | --- |
| **-2 Res Log Likelihood** | -4477.9 |
| **AIC (Smaller is Better)** | -4473.9 |
| **AICC (Smaller is Better)** | -4473.9 |
| **BIC (Smaller is Better)** | -4466.5 |

| **Solution for Fixed Effects** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Effect** | **Estimate** | **Standard Error** | **DF** | **t Value** | **Pr > |t|** |
| **Intercept** | -0.3552 | 0.008179 | 298 | -43.42 | <.0001 |
| **Age** | 0.02981 | 0.000473 | 1693 | 62.99 | <.0001 |