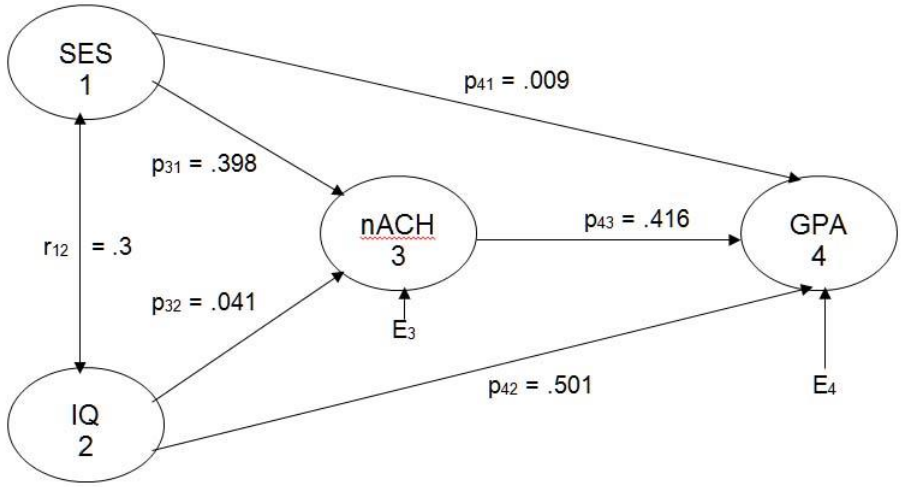
The analysis here is for the model in Figure 1 in my document "An Introduction to Path Analysis ."




```
options formdlim='-' nodate pagno=min;
data Pedhazur(type=corr);
INPUT _TYPE_ $ _NAME_ $ SES IQ nACH GPA;
 CARDS;
CORR SES  1 .30 .41 .33
CORR IQ   .30 1 .16 .57
CORR nACH .41 .16 1 .50
CORR GPA  .33 .57 .50 1
Proc Calis PRINT;
LINEQS
nACH = b1 IQ + b2 SES + E1,
GPA = b3 IQ + b4 SES +b5 nACH + E2;
STD
e1-e2 = V1-V2;
run;
```

| Variables in the Model | | |
|---|---|---|
| **Endogenous** | **Manifest** | GPA nACH |
| | **Latent** | |
| **Exogenous** | **Manifest** | IQ SES |
| | **Latent** | |
| | **Error** | E2 E1 |
| **Number of Endogenous Variables = 2** | | |
| **Number of Exogenous Variables = 4** | | |

| Simple Statistics | | |
|---|---|---|
| **Variable** | **Mean** | **Std Dev** |
| **SES** | 0 | 1.00000 |
| **IQ** | 0 | 1.00000 |

| Simple Statistics | | |
|---|---|---|
| Variable | Mean | Std Dev |
| nACH | 0 | 1.00000 |
| GPA | 0 | 1.00000 |

The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

| Fit Summary | | |
|---|---|---|
| Modeling Info | N Observations | 10000 |
| | N Variables | 4 |
| | N Moments | 10 |
| | N Parameters | 10 |
| | N Active Constraints | 0 |
| Absolute Index | Chi-Square | 0.0000 |
| | Chi-Square DF | 0 |
| | Pr > Chi-Square | . |
| | Root Mean Square Residual (RMSR) | 0.0000 |
| | Goodness of Fit Index (GFI) | 1.0000 |

Since this is a saturated model, the fit is perfect.

| Raw Residual Matrix | | | | |
|---|---|---|---|---|
| | SES | IQ | nACH | GPA |
| SES | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| IQ | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| nACH | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| GPA | 0.00000 | 0.00000 | 0.00000 | -0.00000 |

| | |
|---|---|
| Average Absolute Residual | 6.5720539E-8 |
| Average Off-diagonal Absolute Residual | 0 |

---

| Linear Equations | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nACH | = | 0.0407 | * | IQ | + | 0.3978 | * | SES | + | 1.0000 | | E1 |
| Std Err | | 0.00955 | | b1 | | 0.00955 | | b2 | | | | |
| t Value | | 4.2561 | | | | 41.6412 | | | | | | |
| GPA | = | 0.5007 | * | IQ | + | 0.00919 | * | SES | + | 0.4161 | * nACH + | 1.0000 E2 |
| Std Err | | 0.00745 | | b3 | | 0.00806 | | b4 | | 0.00779 | b5 | |
| t Value | | 67.2419 | | | | 1.1404 | | | | 53.4361 | | |

| Estimates for Variances of Exogenous Variables | | | | | |
|---|---|---|---|---|---|
| **Variable Type** | **Variable** | **Parameter** | **Estimate** | **Standard Error** | **t Value** |
| **Error** | **E1** | V1 | 0.83040 | 0.01174 | 70.70714 |
| | **E2** | V2 | 0.50353 | 0.00712 | 70.70714 |
| **Observed** | **IQ** | _Add1 | 1.00000 | 0.01414 | 70.70714 |
| | **SES** | _Add2 | 1.00000 | 0.01414 | 70.70714 |

| Covariances Among Exogenous Variables | | | | | |
|---|---|---|---|---|---|
| **Var1** | **Var2** | **Parameter** | **Estimate** | **Standard Error** | **t Value** |
| **SES** | **IQ** | _Add3 | 0.30000 | 0.01044 | 28.73335 |

| Squared Multiple Correlations | | | |
|---|---|---|---|
| **Variable** | **Error Variance** | **Total Variance** | **R-Square** |
| **nACH** | 0.83040 | 1.00000 | 0.1696 |
| **GPA** | 0.50353 | 1.00000 | 0.4965 |

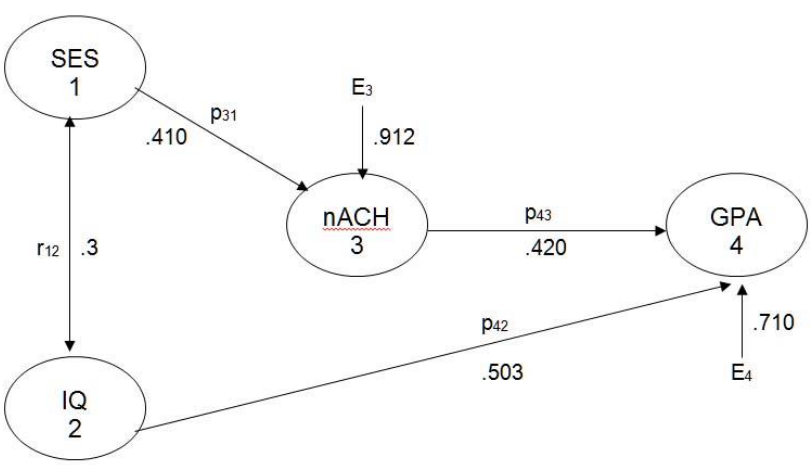
| Total Effects | | | |
|---|---|---|---|
| **Effect / Std Error / t Value / p Value** | | | |
| | **nACH** | **IQ** | **SES** |
| **GPA** | 0.4161 | 0.5176 | 0.1747 |
| | 0.007787 | 0.008435 | 0.008435 |
| | 53.4361 | 61.3648 | 20.7155 |
| | <.0001 | <.0001 | <.0001 |
| **nACH** | 0 | 0.0407 | 0.3978 |
| | | 0.009553 | 0.009553 |
| | | 4.2561 | 41.6412 |
| | | <.0001 | <.0001 |

| Direct Effects | | | |
|---|---|---|---|
| Effect / Std Error / t Value / p Value | | | |
| | nACH | IQ | SES |
| GPA | 0.4161 | 0.5007 | 0.009189 |
| | 0.007787 | 0.007446 | 0.008058 |
| | 53.4361 | 67.2419 | 1.1404 |
| | <.0001 | <.0001 | 0.2541 |
| nACH | 0 | 0.0407 | 0.3978 |
| | | 0.009553 | 0.009553 |
| | | 4.2561 | 41.6412 |
| | | <.0001 | <.0001 |

| Indirect Effects | | | |
|---|---|---|---|
| Effect / Std Error / t Value / p Value | | | |
| | nACH | IQ | SES |
| GPA | 0 | 0.0169 | 0.1655 |
| | | 0.003988 | 0.005040 |
| | | 4.2427 | 32.8458 |
| | | <.0001 | <.0001 |

**Now I remove from the model the direct path from IQ to nACH and from SES to GPA:**

```
Proc Calis PRINT;
LINEQS
nACH = b2 SES + E1,
GPA = b3 IQ + b5 nACH + E2;
STD
e1-e2 = V1-V2;
run;
```



The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

| Fit Summary | | |
|---|---|---|
| **Modeling Info** | **N Observations** | 10000 |
| | **N Variables** | 4 |
| | **N Moments** | 10 |
| | **N Parameters** | 8 |
| | **N Active Constraints** | 0 |
| **Absolute Index** | **Chi-Square** | 19.3988 |
| | **Chi-Square DF** | 2 |
| | **Pr > Chi-Square** | <.0001 |
| | **Goodness of Fit Index (GFI)** | 0.9990 |
| **Parsimony Index** | **Adjusted GFI (AGFI)** | 0.9952 |
| | **RMSEA Estimate** | 0.0295 |
| | **RMSEA Lower 90% Confidence Limit** | 0.0185 |
| | **RMSEA Upper 90% Confidence Limit** | 0.0421 |

Although we reject the null hypothesis of perfect fit, this is meaningless, given the very large sample size. Notice that our fit statistics are still excellent.

Covariance Structure Analysis: Maximum Likelihood Estimation

| Raw Residual Matrix | | | | |
|---|---|---|---|---|
| | **SES** | **IQ** | **nACH** | **GPA** |
| **SES** | 0.00000 | 0.00000 | 0.00000 | 0.00713 |
| **IQ** | 0.00000 | 0.00000 | 0.03700 | 0.01552 |
| **nACH** | 0.00000 | 0.03700 | 0.00000 | 0.01861 |
| **GPA** | 0.00713 | 0.01552 | 0.01861 | 0.01561 |

| | |
|---|---|
| **Average Absolute Residual** | 0.009387 |
| **Average Off-diagonal Absolute Residual** | 0.013043 |

| Linear Equations | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| nACH | = | 0.4100 | * | SES | + | 1.0000 | | | | E1 |
| Std Err | | 0.00912 | | b2 | | | | | | |
| t Value | | 44.9497 | | | | | | | | |
| GPA | = | 0.5029 | * | IQ | + | 0.4195 | * | nACH | + | 1.0000 E2 |
| Std Err | | 0.00715 | | b3 | | 0.00715 | | b5 | | |
| t Value | | 70.3212 | | | | 58.6682 | | | | |

| Covariances Among Exogenous Variables | | | | | |
|---|---|---|---|---|---|
| **Var1** | **Var2** | **Parameter** | **Estimate** | **Standard Error** | **t Value** |
| **IQ** | **SES** | _Add3 | 0.30000 | 0.01044 | 28.73335 |

| Squared Multiple Correlations | | | |
|---|---|---|---|
| **Variable** | **Error Variance** | **Total Variance** | **R-Square** |
| **nACH** | 0.83190 | 1.00000 | 0.1681 |
| **GPA** | 0.50359 | 0.98439 | 0.4884 |

| Total Effects | | | |
|---|---|---|---|
| Effect / Std Error / t Value / p Value | | | |
| | **nACH** | **IQ** | **SES** |
| **GPA** | 0.4195 | 0.5029 | 0.1720 |
| | 0.007151 | 0.007151 | 0.004821 |
| | 58.6682 | 70.3212 | 35.6809 |
| | <.0001 | <.0001 | <.0001 |
| **nACH** | 0 | 0 | 0.4100 |
| | | | 0.009121 |
| | | | 44.9497 |
| | | | <.0001 |

| Direct Effects | | | |
|---|---|---|---|
| Effect / Std Error / t Value / p Value | | | |
| | **nACH** | **IQ** | **SES** |
| **GPA** | 0.4195 | 0.5029 | 0 |
| | 0.007151 | 0.007151 | |
| | 58.6682 | 70.3212 | |
| | <.0001 | <.0001 | |
| **nACH** | 0 | 0 | 0.4100 |
| | | | 0.009121 |
| | | | 44.9497 |
| | | | <.0001 |

| Indirect Effects | | | |
|---|---|---|---|
| Effect / Std Error / t Value / p Value | | | |
| | **nACH** | **IQ** | **SES** |
| **GPA** | 0 | 0 | 0.1720 |
| | | | 0.004821 |
| | | | 35.6809 |
| | | | <.0001 |
| **nACH** | 0 | 0 | 0 |