Multiple linear regression 2

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Categorical variables in regression models.

The changing **reference** level

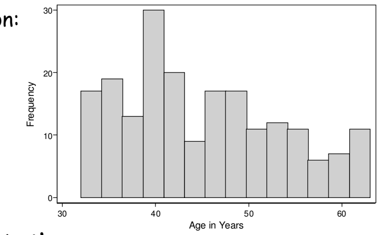
Interaction/effect modification

Interaction between a **categorical** and **continuous** variable

Interaction between two **categorical** variables

Categorical variable in regression models

The age distribution:



Let us divide *age* into **three** agegroups ,

0: *age*≤40, 1: 40<*age*≤50, 2: 50<*age*

and consider the new model

$$\ln(sbp) = \alpha_0 + \boxed{\alpha_1 \cdot age1 + \alpha_2 \cdot age2} + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

Categorical variable : age group 0 reference

$$\ln(sbp) = \alpha_0 + \alpha_1 \cdot age1 + \alpha_2 \cdot age2 + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

age1 is one if a person is in age group **1** and zero otherwise
age2 is one if a person is in age group **2** and zero otherwise

The expected $\ln(sbp)$ in the three age groups will be:

$age \le 40:\quad \ln(sbp) = \alpha_0 \quad + \alpha_3 \cdot woman + \alpha_4 \cdot \ln(bmi/25)$

$40 < age \le 50:\quad \ln(sbp) = \alpha_0 + \alpha_1 \quad + \alpha_3 \cdot woman + \alpha_4 \cdot \ln(bmi/25)$

$50 < age:\quad \ln(sbp) = \alpha_0 + \alpha_2 \quad + \alpha_3 \cdot woman + \alpha_4 \cdot \ln(bmi/25)$

We see that α_1 is the adjusted difference in $\ln(sbp)$ when comparing a person in the **second group** with one in the **first group**.

And α_2 is the adjusted difference in $\ln(sbp)$ when comparing a person in the **third group** with one in the **first group**.

Categorical variable : age group 0 reference

$$\ln(sbp) = \alpha_0 + \alpha_1 \cdot age1 + \alpha_2 \cdot age2 + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

Finally we see that α_0 is the expected $\ln(sbp)$ for a man in the **first** (reference) age group, with *bmi*=25.

In most programs the model is fitted by first generating the grouping variable and then making the regression telling the program which variables are categorical.

In STATA this done like this:

```
egen agegrp3=cut(age), at(0,40,50,120) label

xi: regress lnSBP woman i.agegrp3 lnBMI25
```

Categorical variables included

This is categorical

Categorical variable : age group 0 reference

$$\ln(sbp) = \alpha_0 + \alpha_1 \cdot age1 + \alpha_2 \cdot age2 + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

agegrp3 is treated as categorical

The value 0 is chosen as reference

OUTPUT:

```
i.agegrp3         _Iagegrp3_0-2         (naturally coded; _Iagegrp3_0 omitted)

  Source |       SS       df       MS              Number of obs =     200
---------+------------------------------           F(  4,   195) =   11.20
   Model |  .980169926     4  .245042482           Prob > F      =  0.0000
Residual |  4.26524771   195  .021873065           R-squared     =  0.1869
---------+------------------------------           Adj R-squared =  0.1702
   Total |  5.24541764   199  .026358883           Root MSE      =   .1479
------------------------------------------------------------------------------
       lnSBP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0035403   .0212026     0.17   0.868    -.0382757    .0453562
 _Iagegrp3_1 |   .0715136   .0253373     2.82   0.005     .0215432     .121484
 _Iagegrp3_2 |    .130465   .0280521     4.65   0.000     .0751404    .1857895
     lnBMI25 |   .2898622   .0772432     3.75   0.000     .1375229    .4422015
       _cons |   4.789641   .0224814   213.05   0.000     4.745303    4.833979
------------------------------------------------------------------------------
```


Categorical variable : age group 0 reference

$$\ln(sbp) = \alpha_0 + \alpha_1 \cdot age1 + \alpha_2 \cdot age2 + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

Adjusted difference between for a person in **age group 1** compared to **age group 0**

```
------------------------------------------------------------------------------
       lnSBP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0035403   .0212026     0.17   0.868    -.0382757    .0453562
 _Iagegrp3_1 |   .0715136   .0253373     2.82   0.005     .0215432     .121484
 _Iagegrp3_2 |    .130465   .0280521     4.65   0.000     .0751404    .1857895
     lnBMI25 |   .2898622   .0772432     3.75   0.000     .1375229    .4422015
       _cons |   4.789641   .0224814   213.05   0.000     4.745303    4.833979
------------------------------------------------------------------------------
```

Adjusted difference between for a person in **age group 2** compared to **age group 0**

Expected value for a man in **age group 0** with *bmi*=25.

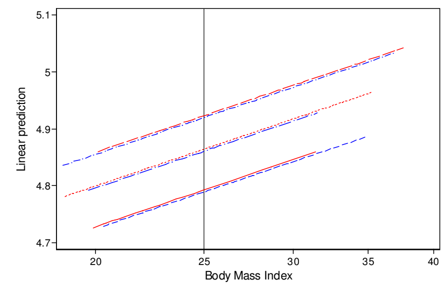
The expected values:

$$
\begin{array}{lll}
age \le 40: & \ln(sbp) = \alpha_0 & +\alpha_3 \cdot woman + \alpha_4 \cdot \ln(bmi/25) \\
40 < age \le 50: & \ln(sbp) = \alpha_0 + \alpha_1 & +\alpha_3 \cdot woman + \alpha_4 \cdot \ln(bmi/25) \\
50 < age: & \ln(sbp) = \alpha_0 + \alpha_2 & +\alpha_3 \cdot woman + \alpha_4 \cdot \ln(bmi/25)
\end{array}
$$

The estimates

```
      lnSBP |      Coef.
-------------+-----------
       woman |   .003540        3
 _Iagegrp3_1 |   .071514        1
 _Iagegrp3_2 |   .130465        2
     lnBMI25 |   .289862        4
       _cons |  4.789641        0
```

$$
\begin{array}{ll}
age \le 40: & \ln(sbp) = 4.789 + \quad 0.004 \cdot woman + 0.290 \cdot \ln(bmi/25) \\
40 < age \le 50: & \ln(sbp) = 4.789 + 0.072 + 0.004 \cdot woman + 0.290 \cdot \ln(bmi/25) \\
50 < age: & \ln(sbp) = 4.789 + 0.130 + 0.004 \cdot woman + 0.290 \cdot \ln(bmi/25)
\end{array}
$$



Agegroup	Women	Men
0:	$4.793 + 0.290 \cdot \ln(bmi/25)$	$4.790 + 0.290 \cdot \ln(bmi/25)$
1:	$4.865 + 0.290 \cdot \ln(bmi/25)$	$4.861 + 0.290 \cdot \ln(bmi/25)$
2:	$4.924 + 0.290 \cdot \ln(bmi/25)$	$4.920 + 0.290 \cdot \ln(bmi/25)$

Categorical variable : age group 1 reference

$$\ln(sbp) = \gamma_0 + \gamma_1 \cdot age0 + \gamma_2 \cdot age2 + \gamma_3 \cdot woman + \gamma_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

$age0$ is one if a person is in age group **0** and zero otherwise
$age2$ is one if a person is in age group **2** and zero otherwise

The expected $\ln(sbp)$ in the three age groups will be:

$$
\begin{array}{lll}
age \le 40: & \ln(sbp) = \gamma_0 + \gamma_1 & +\gamma_3 \cdot woman + \gamma_4 \cdot \ln(bmi/25) \\
40 < age \le 50: & \ln(sbp) = \gamma_0 & +\gamma_3 \cdot woman + \gamma_4 \cdot \ln(bmi/25) \\
50 < age: & \ln(sbp) = \gamma_0 + \gamma_2 & +\gamma_3 \cdot woman + \gamma_4 \cdot \ln(bmi/25)
\end{array}
$$

We see that γ_1 is the adjusted difference in $\ln(sbp)$ when comparing a person in the **first group** with one in the **second group**.

And γ_2 is the adjusted difference in $\ln(sbp)$ when comparing a person in the **third group** with one in the **second group**.

Categorical variable : age group 1 reference

$$\ln(sbp) = \gamma_0 + \gamma_1 \cdot age0 + \gamma_2 \cdot age2 + \gamma_3 \cdot woman + \gamma_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

Finally we see that γ_0 is the expected $\ln(sbp)$ for a man in the **second** (reference) age group, with bmi=25.

Many programs (but regression in SPSS) let you chose the reference group

In STATA this done like this:

```
char agegrp3[omit]1
```

The group label 1 is reference

```
xi: regress lnSBP woman i.agegrp3 lnBMI25
```

Categorical variables included

This is categorical

Categorical variable : age group 1 reference

$$\ln(sbp) = \gamma_0 + \gamma_1 \cdot age0 + \gamma_2 \cdot age2 + \gamma_3 \cdot woman + \gamma_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

`agegrp3` is treated as categorical

The value 1 is chosen as reference

```
i.agegrp3         _Iagegrp3_0-2     (naturally coded; _Iagegrp3_1 omitted)

  Source |       SS       df       MS              Number of obs =     200
---------+------------------------------           F(  4,   195) =   11.20
   Model |  .980169926     4  .245042482           Prob > F      =  0.0000
Residual |  4.26524771   195  .021873065           R-squared     =  0.1869
---------+------------------------------           Adj R-squared =  0.1702
   Total |  5.24541764   199  .026358883           Root MSE      =   .1479
------------------------------------------------------------------------------
      lnSBP |      Coef.   Std. Err.      t     P>|t|      [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0035403   .0212026     0.17   0.868    -.0382757    .0453562
 _Iagegrp3_0 |  -.0715136   .0253373    -2.82   0.005    -.121484    -.0215432
 _Iagegrp3_2 |   .0589513   .0263496     2.24   0.026     .0069846    .1109181
     lnBMI25 |   .2898622   .0772432     3.75   0.000     .1375229    .4422015
       _cons |  4.861154    .0207406    234.4   0.000    4.82025     4.902059
------------------------------------------------------------------------------
```


Categorical variable : age group 1 reference

$$\ln(sbp) = \alpha_0 + \alpha_1 \cdot age1 + \alpha_2 \cdot age2 + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

Adjusted difference between for a person in **age group 0** compared to **age group 1**

```
------------------------------------------------------------------------------
      lnSBP |      Coef.   Std. Err.      t     P>|t|      [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0035403   .0212026     0.17   0.868    -.0382757    .0453562
 _Iagegrp3_0 |  -.0715136   .0253373    -2.82   0.005    -.121484    -.0215432
 _Iagegrp3_2 |   .0589513   .0263496     2.24   0.026     .0069846    .1109181
     lnBMI25 |   .2898622   .0772432     3.75   0.000     .1375229    .4422015
       _cons |  4.861154    .0207406    234.4   0.000    4.82025     4.902059
------------------------------------------------------------------------------
```

Adjusted difference between for a person in **age group 2** compared to **age group 1**

Expected value for a man in **age group 1** with bmi=25.

Categorical variable: Comparing to parameterizations

$$\ln(sbp) = \alpha_0 + \alpha_1 \cdot age1 + \alpha_2 \cdot age2 + \alpha_3 \cdot woman + \alpha_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

$$\ln(sbp) = \gamma_0 + \gamma_1 \cdot age0 + \gamma_2 \cdot age2 + \gamma_3 \cdot woman + \gamma_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

age group 0: $\alpha_0 = \gamma_0 + \gamma_1$

age group 1: $\alpha_0 + \alpha_1 = \gamma_0$

age group 2: $\alpha_0 + \alpha_2 = \gamma_0 + \gamma_2$

$\alpha_0 = \gamma_0 + \gamma_1$	$\gamma_0 = \alpha_0 + \alpha_1$
$\alpha_1 = -\gamma_1$	$\gamma_1 = -\alpha_1$
$\alpha_2 = \gamma_2 - \gamma_1$	$\gamma_2 = \alpha_2 - \alpha_1$
$\alpha_3 = \gamma_3$	$\gamma_3 = \alpha_3$
$\alpha_4 = \gamma_4$	$\gamma_4 = \alpha_4$

Categorical variable: Comparing two parameterizations

The estimates:

age group 0 reference

```
 Root MSE      =   .1479
------------------------------------
     lnSBP |   Coef.     [95% CI]
-----------+------------------------
     woman | .0035 -.0382  .0453
_Iagegrp3_1 | .0715  .0215  .1214
_Iagegrp3_2 | .1304  .0751  .1857
   lnBMI25 | .2898  .1375  .4422
     _cons |4.7896  4.745  4.833
------------------------------------
```

age group 1 reference

```
     Root MSE      =   .1479
--------------------------------------
      lnSBP |    Coef.       [95% CI]
-----------+--------------------------
      woman|  .0035   -.0382   .0453
_Iagegrp3_0| -.0715   -.1214  -.0215
_Iagegrp3_2|  .0589    .0069    .1109
    lnBMI25 |  .2898    .1375    .4422
      _cons | 4.8611    4.820   4.902
--------------------------------------
```

Note, the estimates fulfil the same equations.

The interpretation of the "`_Iagegrp3_2` line" and "`_cons` line" are altered!!!!!!!!!

Always remember: what is the reference group!

Categorical variable : age group 1 reference

```
------------------------------------------------------------------------------
      lnSBP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      woman |   .0035403   .0212026    0.17   0.868    -.0382757    .0453562
_Iagegrp3_0 |  -.0715136   .0253373   -2.82   0.005     -.121484   -.0215432
_Iagegrp3_2 |   .0589513   .0263496    2.24   0.026     .0069846    .1109181
    lnBMI25 |   .2898622   .0772432    3.75   0.000     .1375229    .4422015
      _cons |  4.861154    .0207406   234.4   0.000    4.82025     4.902059
------------------------------------------------------------------------------
```

Two test:

One testing no difference between age group **0** and **1**.
One testing no difference between age group **2** and **1**.

Can we get **one test** testing no difference between age groups?

A F-test in STATA: *testparm _Iagegrp3**

```
 ( 1)  _Iagegrp3_0 = 0
 ( 2)  _Iagegrp3_2 = 0
F(  2,   195) =    10.93
     Prob > F =    0.0000
```

Highly significant

Interactions/effectmodification

$$\ln(sbp) = \gamma_0 + \gamma_1 \cdot age0 + \gamma_2 \cdot age2 + \gamma_3 \cdot woman + \gamma_4 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

One of the **central** assumptions was "no effect modification".

E.g. in model above the "effect" of **age**, **sex** and **bmi** did not depend on the value of each other.

One can **introduce** effect modification between a categorical variable and another variable.

Here we first will look at **agegr3** and **lnBMI25**.

The effect modification will be that the coefficient to **lnBMI25** depend on **age group**.

That is, we will allow **different effect** of bmi in the **different age** groups.

Interactions/effectmodification

$$\ln(sbp) = \omega_0 + \omega_1 \cdot age0 + \omega_2 \cdot age2 + \omega_3 \cdot woman$$
$$+ \omega_4 \cdot \ln\left(\frac{bmi}{25}\right) + \omega_5 \cdot age0 \cdot \ln\left(\frac{bmi}{25}\right) + \omega_6 \cdot age2 \cdot \ln\left(\frac{bmi}{25}\right) + E$$

$age \le 40: \quad \ln(sbp) = (\omega_0 + \omega_1) + (\omega_4 + \omega_5) \cdot \ln\left(\frac{bmi}{25}\right) + \omega_3 \cdot woman$

$40 < age \le 50: \quad \ln(sbp) = \omega_0 + \omega_4 \cdot \ln\left(\frac{bmi}{25}\right) + \omega_3 \cdot woman$

$50 < age: \quad \ln(sbp) = (\omega_0 + \omega_2) + (\omega_4 + \omega_6) \cdot \ln\left(\frac{bmi}{25}\right) + \omega_3 \cdot woman$

ω_1 is the **difference** between the constant for age **group 0** and **reference** group.
ω_5 is the **difference** between the coefficient to `lnBMI25` for age **group 0** and **reference** group.

Interactions/effectmodification

```
 xi: regress lnSBP woman i.agegrp3*lnBMI25

i.agegrp3         _Iagegrp3_0-2     (naturally coded; _Iagegrp3_1 omitted)
i.ageg~3*lnB~25   _IageXlnBMI_#     (coded as above)

  Source |       SS       df       MS              Number of obs =      200
---------+------------------------------           F(  6,   193) =     7.53
   Model |  .994860827     6  .165810138           Prob > F      =   0.0000
Residual |  4.25055681   193   .02202361           R-squared     =   0.1897
---------+------------------------------           Adj R-squared =   0.1645
   Total |  5.24541764   199  .026358883           Root MSE      =    .1484

--------------------------------------------------------------------------
       lnSBP |    Coef.    Std. E.     t   P>|t|    [95% Conf. Interval]
-------------+------------------------------------------------------------
       woman |   .0076438   .02191    0.35  0.728   -.03558     .0508772
 _Iagegrp3_0 |  -.0708045   .02611   -2.71 0.007  -.1223213   -.0192877
 _Iagegrp3_2 |   .0631082   .02703    2.33  0.021   .009787    .1164287
     lnBMI25 |   .3155479   .12229    2.58  0.011   .074350    .5567453
_IageXlnBM~0 |   .0429736   .19123    0.22  0.822  -.334209     .420157
_IageXlnBM~2 |  -.1165375   .18554   -0.63  0.531  -.482499    .2494241
       _cons |   4.859743   .02141   226.9  0.000   4.81751     4.901975
--------------------------------------------------------------------------
```

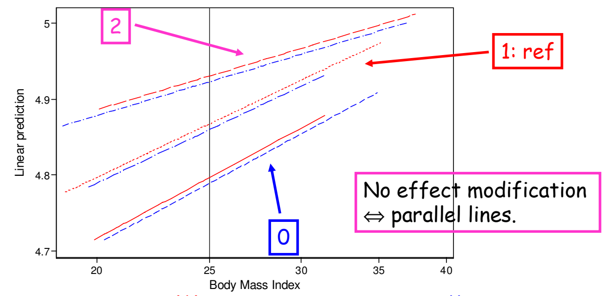
Interactions/effect modification

Ref: constant and 'slope' in reference group
0: difference in constant and slope compared to reference
2: difference in constant and slope compared to reference

```
------------------------------------------------------------------------------
       lnSBP |     Coef.   Std. E.     t    P>|t|   [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0076438   .02191    0.35  0.728  -.03558       .0508772
0_Iagegrp3_0 |  -.0708045   .02611   -2.71  0.007  -.1223213    -.0192877
 _Iagegrp3_2 |   .0631082   .02703    2.33  0.021   .009787      .1164287 2
     lnBMI25 |   .3155479   .12229    2.58  0.011   .074350      .5567453Ref
0IageXlnBM~0 |   .0429736   .19123    0.22  0.822  -.334209       .420157
_IageXlnBM~2 |  -.1165375   .18554   -0.63  0.531  -.482499      .2494241 2
       _cons |   4.859743   .02141   226.9  0.000   4.81751      4.90197Ref
------------------------------------------------------------------------------
```

Note the larger standard errors

Based on the estimates one can find the six "dose-response" curves:



Agegroup	Women	Men
0:	$4.797 + 0.359 \cdot \ln(bmi/25)$	$4.789 + 0.359 \cdot \ln(bmi/25)$
1:	$4.867 + 0.316 \cdot \ln(bmi/25)$	$4.860 + 0.316 \cdot \ln(bmi/25)$
2:	$4.930 + 0.199 \cdot \ln(bmi/25)$	$4.923 + 0.199 \cdot \ln(bmi/25)$

Interactions/effect modification

```
------------------------------------------------------------------------------
       lnSBP |     Coef.   Std. E.     t    P>|t|   [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0076438   .02191    0.35  0.728  -.03558       .0508772
 _Iagegrp3_0 |  -.0708045   .02611   -2.71  0.007  -.12232      -.0192877
 _Iagegrp3_2 |   .0631082   .02703    2.33  0.021   .009787      .1164287
     lnBMI25 |   .3155479   .12229    2.58  0.011   .074350      .5567453
_IageXlnBM~0 |   .0429736   .19123    0.22  0.822  -.334209       .420157
_IageXlnBM~2 |  -.1165375   .18554   -0.63  0.531  -.482499      .2494241
       _cons |   4.859743   .02141   226.9  0.000   4.81751      4.901975
------------------------------------------------------------------------------
```

Two test:
One testing differences between "slope" in age group **0** and **1**.
One testing differences between "slope" in age group **2** and **1**.

Can we get **one test** testing no difference between age groups?

A F-test in STATA: *testparm* _IageX*

```
 ( 1)  _IageXlnBMI_0 = 0
 ( 2)  _IageXlnBMI_2 = 0
       F(  2,   193) =     0.33
            Prob > F =    0.7168
```

Non-significant

Interactions/effect modification

The test of no interaction was non-significant.

But look at the **confidence interval** for the difference in slope for between age group **2** and group **1** !

```
------------------------------------------------------------------------------
       lnSBP |     Coef.   Std. E.     t    P>|t|   [95% Conf. Interval]
-------------+----------------------------------------------------------------
       woman |   .0076438   .02191    0.35  0.728  -.03558       .0508772
 _Iagegrp3_0 |  -.0708045   .02611   -2.71  0.007  -.1223213    -.0192877
 _Iagegrp3_2 |   .0631082   .02703    2.33  0.021   .009787      .1164287
     lnBMI25 |   .3155479   .12229    2.58  0.011   .074350      .5567453
_IageXlnBM~0 |   .0429736   .19123    0.22  0.822  -.334209       .420157
_IageXlnBM~2 |  -.1165375   .18554   -0.63  0.531  -.482499      .2494241
       _cons |   4.859743   .02141   226.9  0.000   4.81751      4.901975
------------------------------------------------------------------------------
```

It is very wide!!! We know very little about this difference!

The test for no interaction has **very low power**!!!

The data have very **little information** on whether there is effect modification.

Interaction between age group and sex

xi: regress lnSBP lnBMI25 **i.agegrp3*i.sex**

```
i.agegrp3         _Iagegrp3_0-2       (naturally coded; _Iagegrp3_1 omitted)
i.sex             _Isex_1-2           (naturally coded; _Isex_1 omitted)
i.age~3*i.sex     _IageXsex_#_#       (coded as above)

      Source |       SS       df       MS              Number of obs =     200
-------------+------------------------------           F(  6,   193) =    9.96
       Model |  1.24006476     6  .20667746           Prob > F      =  0.0000
    Residual |  4.00535288   193  .020753124           R-squared     =  0.2364
-------------+------------------------------           Adj R-squared =  0.2127
       Total |  5.24541764   199  .026358883           Root MSE      =  .14406

------------------------------------------------------------------------------
       lnSBP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lnBMI25 |   .2265018   .0774898     2.92   0.004     .0736662    .3793374
 _Iagegrp3_0 |  -.0426734   .0377096    -1.13   0.259    -.1170493    .0317025
 _Iagegrp3_2 |  -.0025412   .0365457    -0.07   0.945    -.0746215    .0695391
      _Isex_2 |  -.0210869   .0322283    -0.65   0.514    -.0846518     .042478
_IageXse~0_2 |  -.0548967   .0501668    -1.09   0.275    -.1538422    .0440488
_IageXse~2_2 |    .133379   .0501308     2.66   0.008     .0345043    .2322536
       _cons |   4.873442   .0251767   193.57   0.000     4.823786    4.923099
------------------------------------------------------------------------------

. testparm _IageX*
 ( 1)  _IageXsex_0_2 = 0
 ( 2)  _IageXsex_2_2 = 0
       F(  2,   193) =     6.26
            Prob > F =    0.0023
```

Highly significant

Interaction between age group and sex

Differences between age groups among men is small

```
------------------------------------------------------------------------------
       lnSBP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lnBMI25 |   .2265018   .0774898     2.92   0.004     .0736662    .3793374
 _Iagegrp3_0 |  -.0426734   .0377096    -1.13   0.259    -.1170493    .0317025
 _Iagegrp3_2 |  -.0025412   .0365457    -0.07   0.945    -.0746215    .0695391
      _Isex_2 |  -.0210869   .0322283    -0.65   0.514    -.0846518     .042478
_IageXse~0_2 |  -.0548967   .0501668    -1.09   0.275    -.1538422    .0440488
_IageXse~2_2 |    .133379   .0501308     2.66   0.008     .0345043    .2322536
       _cons |   4.873442   .0251767   193.57   0.000     4.823786    4.923099
------------------------------------------------------------------------------
```

-0.097

Women age group 1: $4.873 - 0.021 = 4.894$
Women age group 0: $4.873 - 0.021 \boxed{-0.042 - 0.055} = 4.755$
Women age group 2: $4.873 - 0.021 \boxed{-0.003 + 0.133} = 4.982$

0.130

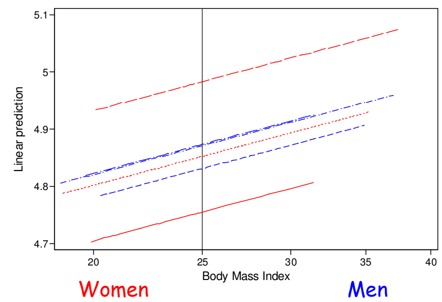
Large difference in the age groups among women.

Interaction between age group and sex

Using women as reference: `char sex[omit]2`

Large differences between age groups among women

```
------------------------------------------------------------------------------
       lnSBP |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lnBMI25 |   .2265018   .0774898     2.92   0.004     .0736662    .3793374
 _Iagegrp3_0 |  -.0975701   .0328469    -2.97   0.003    -.162355    -.0327852
 _Iagegrp3_2 |   .1308378   .0354804     3.69   0.000     .0608587    .2008168
     _Isex_1 |   .0210869   .0322283     0.65   0.514    -.042478     .0846518
_IageXse~0_1 |   .0548967   .0501668     1.09   0.275    -.0440488    .1538422
_IageXse~2_1 |  -.133379    .0501308    -2.66   0.008    -.2322536   -.0345043
       _cons |   4.852355   .0205502   236.12   0.000     4.811824    4.892887
------------------------------------------------------------------------------
```

Agegroup	Women	Men
0:	$4.755+0.227\cdot\ln(bmi/25)$	$4.831+0.227\cdot\ln(bmi/25)$
1:	$4.894+0.227\cdot\ln(bmi/25)$	$4.873+0.227\cdot\ln(bmi/25)$
2:	$4.982+0.227\cdot\ln(bmi/25)$	$4.875+0.227\cdot\ln(bmi/25)$