Multiple linear regression 2
Prior Stata 11

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Categorical variables in regression models.

The changing **reference** level

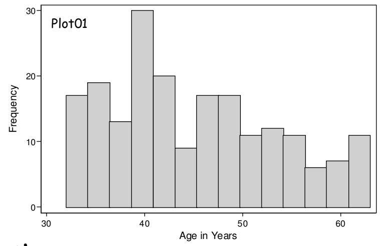
Interaction/effect modification

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: $age \le 40$, 1: $40 < age \le 50$, 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

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

$age\mathbf{1}$ is one if a person is in age group **1** and zero otherwise

$age\mathbf{2}$ is one if a person is in age group **2** and zero otherwise

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

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

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

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

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 is 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.

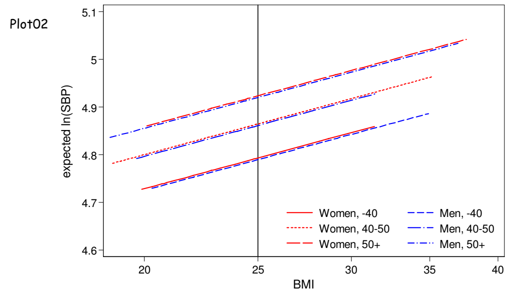
The expected values:

$$age<40: \quad \ln(sbp)=\alpha_0 \qquad +\alpha_3\cdot woman+\alpha_4\cdot\ln(bmi/25)$$
$$40\le age<50: \quad \ln(sbp)=\alpha_0+\alpha_1 \quad +\alpha_3\cdot woman+\alpha_4\cdot\ln(bmi/25)$$
$$50\le age: \quad \ln(sbp)=\alpha_0+\alpha_2 \quad +\alpha_3\cdot woman+\alpha_4\cdot\ln(bmi/25)$$

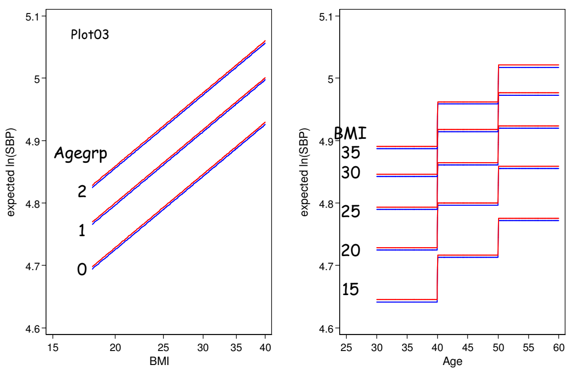
The estimates

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

$$age<40: \quad \ln(sbp)=4.789+ \qquad 0.004\cdot woman+0.290\cdot\ln(bmi/25)$$
$$40\le age<50: \quad \ln(sbp)=4.789+0.072+0.004\cdot woman+0.290\cdot\ln(bmi/25)$$
$$50\le age: \quad \ln(sbp)=4.789+0.130+0.004\cdot woman+0.290\cdot\ln(bmi/25)$$



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:

$$age<40: \quad \ln(sbp)=\gamma_0+\gamma_1 \quad +\gamma_3\cdot woman+\gamma_4\cdot\ln(bmi/25)$$
$$40\le age<50: \quad \ln(sbp)=\gamma_0 \qquad +\gamma_3\cdot woman+\gamma_4\cdot\ln(bmi/25)$$
$$50\le age: \quad \ln(sbp)=\gamma_0+\gamma_2 \quad +\gamma_3\cdot woman+\gamma_4\cdot\ln(bmi/25)$$

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 choose the reference group

In Stata this is done like this:

```
char agegrp3[omit]1
xi: regress lnSBP woman i.agegrp3 lnBMI25
```

The group label 1 is reference

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

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

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 two 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?

An 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 the 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

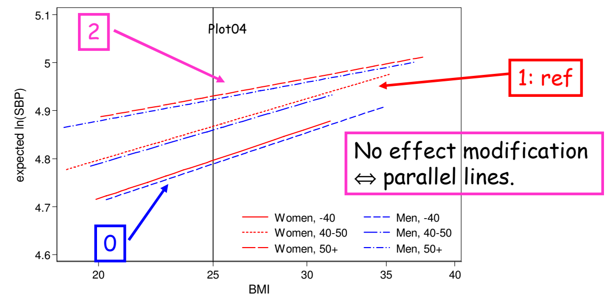
0: difference in constant and slope compared to reference

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     .050877
0_Iagegrp3_0| -.0708045   .02611  -2.71  0.007   -.1223213  -.019287
_Iagegrp3_2 |  .0631082   .02703   2.33  0.021    .009787    .116428   2
    lnBMI25 |  .3155479   .12229   2.58  0.011    .074350    .556745   Ref
0_IagexlnBM~0|  .0429736   .19123   0.22  0.822   -.334209    .420157
_IagexlnBM~2| -.1165375   .18554  -0.63  0.531   -.482499    .249424   2
      _cons |  4.859743   .02141 226.9   0.000    4.81751    4.901975   Ref
```

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** Male sex==1

```
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 are 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

Women age group 1: $4.873-0.021=4.852$

Women age group 0: $4.873-0.021-0.042-0.055=4.755$ (-0.097)

Women age group 2: $4.873-0.021-0.003+0.133=4.982$ (0.130)

Large differences in the age groups among women.

Morten Frydenberg Linear and Logistic regression - Note 2.2 25

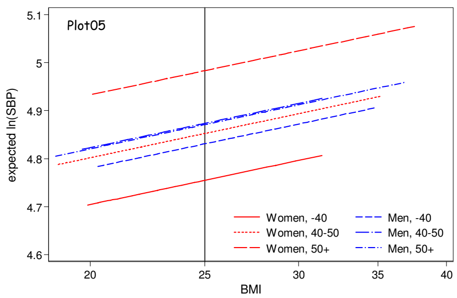
Interaction between age group and sex

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

Morten Frydenberg Linear and Logistic regression - Note 2.2 26



Agegroup	Women	Men
0:	$4.755+0.227\cdot\ln(bmi/25)$	$4.831+0.227\cdot\ln(bmi/25)$
1:	$4.852+0.227\cdot\ln(bmi/25)$	$4.873+0.227\cdot\ln(bmi/25)$
2:	$4.982+0.227\cdot\ln(bmi/25)$	$4.871+0.227\cdot\ln(bmi/25)$

Morten Frydenberg Linear and Logistic regression - Note 2.2 27