Logistic Regression Analysis for Breastfeeding of Nepalese Children

Scientific Question: determine whether and how bf behavior varies with age and/or sex of child.

Data: Nepal Data, Y_{ij}=I(breastfeeding$_{ij}$)

Use the equally-spaced times (same method as in the Midterm);

```
. egen newid=group(id)
. summ newid

    Variable |     Obs       Mean   Std. Dev.       Min       Max
-------------+--------------------------------------------------------
       newid |    1000      100.5   57.76319         1       200


. drop id
. ren newid id
. sort id age
. by id: gen obsno=_n

. tab obsno

      obsno |      Freq.     Percent       Cum.
------------+-----------------------------------
          1 |        200       20.00      20.00
          2 |        200       20.00      40.00
          3 |        200       20.00      60.00
          4 |        200       20.00      80.00
          5 |        200       20.00     100.00
------------+-----------------------------------
      Total |       1000      100.00. tsset id obsno


. tsset id obsno
       panel variable:  id, 1 to 200
        time variable:  obsno, 1 to 5
```

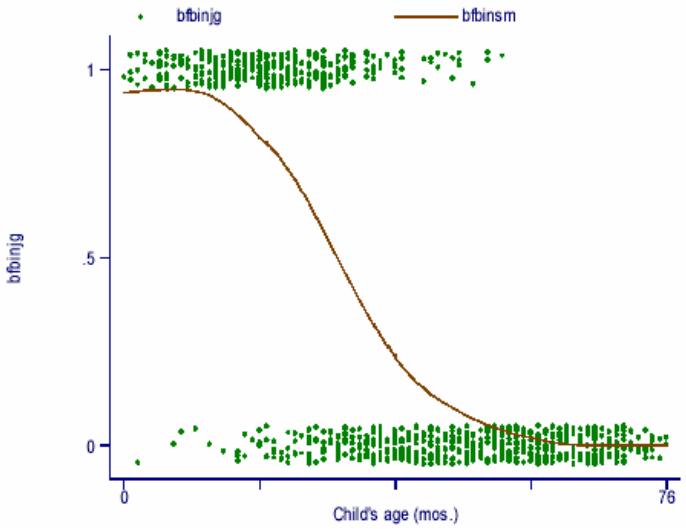
. ***Generate binary breastfeeding variable (ever vs. never)***

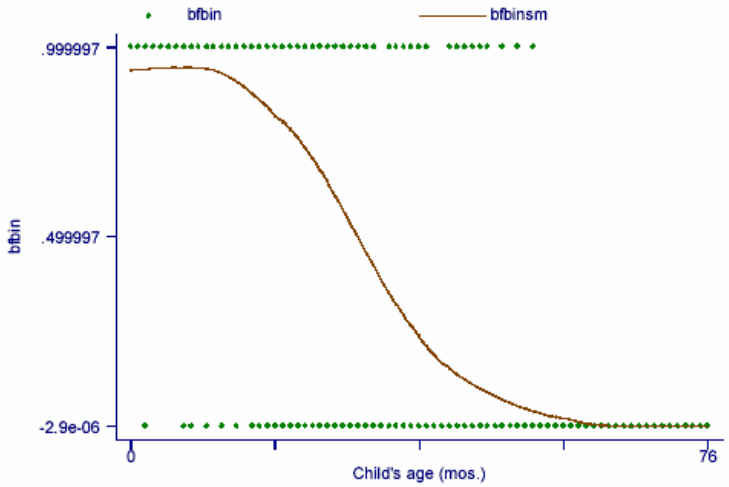
```
. xttab bf

              Overall           Between          Within
     bf |    Freq.  Percent     Freq.  Percent       Percent
---------+-----------------------------------------------------
      0 |     564    59.56       142    71.36         82.46
      1 |     151    15.95        77    38.69         40.81
      2 |     232    24.50        86    43.22         56.45
---------+-----------------------------------------------------
   Total |     947   100.00       305   153.27         64.61
                                                    (n = 199)



. label list
```

```
bf:
        0    none
        1    <10 times/day
        2     >=10 times/day
sex:
        1    male
        2   female
        3

. gen bfbin=1*(bf==1|bf==2)
. gen bfbin=1*(bf==1|bf==2)

. tab bf bfbin

Current
breastfeeding  |          bfbin
        level  |         0          1   | Total
---------------+----------------------+----------
          none |       564          0   |   564
<10 times/day  |         0        151   |   151
>=10 times/day |         0        232   |   232
---------------+----------------------+----------
         Total |       564        383   |
```

Explore marginal mean model wrt age

```
ksm bfbin age, lowess bw(.4) xlab ylab(0(.2)1) nograph gen(bfbinsm)
sort age
gr bfbin bfbinsm age, c(.L) s(oi) ylab

gen bfbinjg=bfbin+.1*(uniform()-.5)
sort age
gr bfbinjg bfbinsm age, c(.L) s(oi) ylab
```





It appears that the logistic function will be appropriate for modeling the effects of child's age on prevalence of bf.

Review of Logistic regression in STATA without taking into account the correlation

```
. gen agesex=age*sex

. logit bfbin age sex agesex

Iteration 0:   log likelihood = -665.51369
Iteration 1:   log likelihood = -372.84807
Iteration 2:   log likelihood = -327.36492
Iteration 3:   log likelihood = -318.37149
Iteration 4:   log likelihood = -317.73989
Iteration 5:   log likelihood = -317.73456
Iteration 6:   log likelihood = -317.73456

Logit estimates                                   Number of obs   =      1000
                                                  LR chi2(3)      =    695.56
                                                  Prob > chi2     =    0.0000
Log likelihood = -317.73456                       Pseudo R2       =    0.5226

------------------------------------------------------------------------------
       bfbin |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |  -.1313039   .0301624    -4.35   0.000    -.1904212   -.0721865
         sex |   .3728255   .6397586     0.58   0.560    -.8810782    1.626729
      agesex |  -.0196382   .0204261    -0.96   0.336    -.0596727    .0203963
       _cons |   4.215441   .9741133     4.33   0.000     2.306214    6.124668
------------------------------------------------------------------------------
```

Report Odds Ratio instead of log Odds Ratio as coefficients:

```
. logistic bfbin age sex agesex

Logit estimates                                   Number of obs   =      1000
                                                  LR chi2(3)      =    695.56
                                                  Prob > chi2     =    0.0000
Log likelihood = -317.73456                       Pseudo R2       =    0.5226

------------------------------------------------------------------------------
       bfbin | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         age |   .8769513    .026451    -4.35   0.000     .8266109    .9303573
         sex |   1.451831   .9288213     0.58   0.560     .4143359    5.087209
      agesex |   .9805533   .0200289    -0.96   0.336     .9420728    1.020606
------------------------------------------------------------------------------

. predict prob
(option p assumed; Pr(bfbin))

. *** sensitivity and specificity from 2 by 2 table ***
. gen c = .5
. gen bfhat = 1 if prob > c
(608 missing values generated)
. replace bfhat = 0 if bfhat == .
(608 real changes made)
. tab bfbin bfhat

           |       bfhat
     bfbin |         0          1 |     Total
-----------+----------------------+----------
         0 |       544         73 |       617
         1 |        64        319 |       383
-----------+----------------------+----------
     Total |       608        392 |      1000
```

```
. *** test for statistical significance ***
. test agesex
 ( 1)  agesex = 0.0

           chi2(  1) =    0.92
         Prob > chi2 =    0.3363

. test sex agesex
 ( 1)  sex = 0.0
 ( 2)  agesex = 0.0

           chi2(  2) =    1.98
         Prob > chi2 =    0.3710
```

Fit GEE model w/ AR(1)

```
. xtgee bfbin sex age agesex, f(bin) link(logit) corr(ar1)

Iteration 1: tolerance = .1830486
Iteration 2: tolerance = .01876749
Iteration 3: tolerance = .00125261
Iteration 4: tolerance = .00004341
Iteration 5: tolerance = 2.666e-06
Iteration 6: tolerance = 1.167e-07

GEE population-averaged model                 Number of obs     =     1000
Group and time vars:           id obsno       Number of groups  =      200
Link:                          logit       Obs per group: min =        5
Family:                      binomial                    avg =      5.0
Correlation:                    AR(1)                    max =        5
                                          Wald chi2(3)      =   112.36
Scale parameter:                     1    Prob > chi2       =   0.0000

------------------------------------------------------------------------------
      bfbin |     Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
        sex |   .1411955   .9366279     0.15   0.880    -1.694562    1.976953
        age |  -.1409907   .0449762    -3.13   0.002    -.2291423    -.052839
     agesex |  -.0103829   .0297624    -0.35   0.727    -.0687161    .0479504
      _cons |   4.334149   1.447124     3.00   0.003     1.497837     7.17046
------------------------------------------------------------------------------

. test sex agesex
 ( 1)  sex = 0.0
 ( 2)  agesex = 0.0

           chi2(  2) =    0.39
         Prob > chi2 =    0.8218
```

Remove interaction:

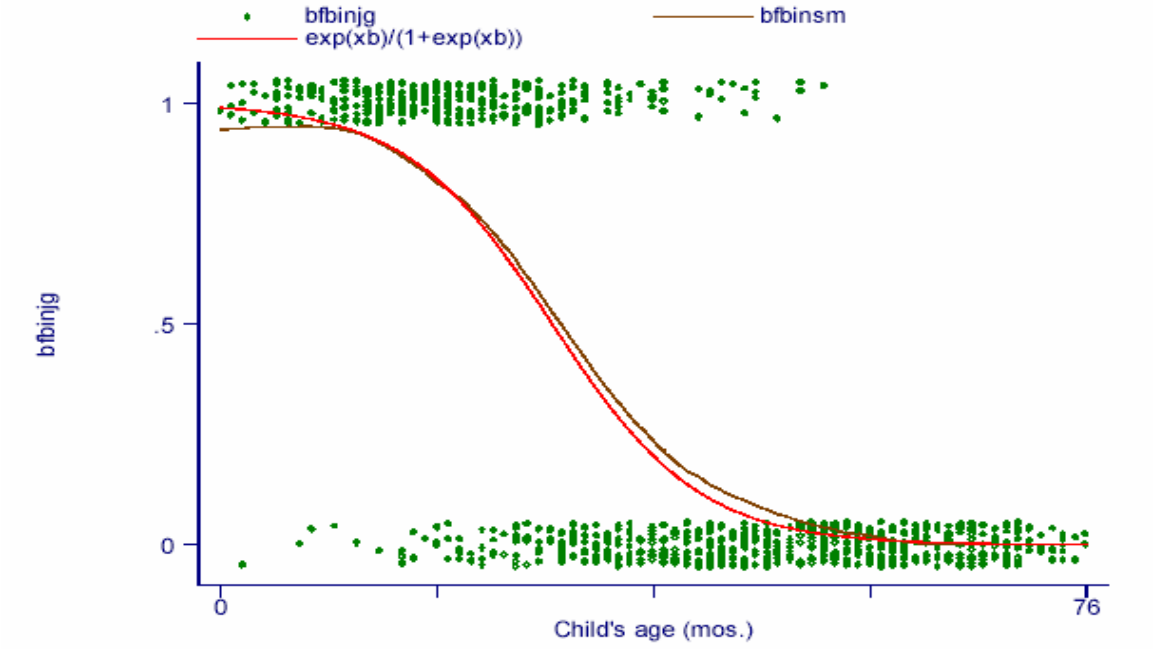
```
. xtgee bfbin  age, f(bin) link(logit) corr(ar1)

Iteration 1: tolerance = .03838573
Iteration 2: tolerance = .0042243
Iteration 3: tolerance = .0001424
Iteration 4: tolerance = 6.738e-06
Iteration 5: tolerance = 2.780e-07

GEE population-averaged model                 Number of obs     =     1000
Group and time vars:           id obsno       Number of groups  =      200
Link:                          logit       Obs per group: min =        5
Family:                      binomial                    avg =      5.0
```

```
Correlation:                      AR(1)                       max =        5
                                                        Wald chi2(1)      =    112.34
Scale parameter:                     1      Prob > chi2       =    0.0000

------------------------------------------------------------------------------
      bfbin |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
        age |  -.1554856   .0146696   -10.60   0.000    -.1842375   -.1267336
      _cons |   4.525001   .4653168     9.72   0.000     3.612997    5.437005
------------------------------------------------------------------------------

. xtcorr, compact

Error structure: AR(1)
Estimated within-id autocorrelation: 0.6518

. xtcorr

Estimated within-id correlation matrix R:

       c1     c2     c3     c4     c5
r1  1.0000
r2  0.6518  1.0000
r3  0.4248  0.6518  1.0000
r4  0.2769  0.4248  0.6518  1.0000
r5  0.1805  0.2769  0.4248  0.6518  1.0000
```

Interpretation and conclusion: Sex of child is not significant predictor of bf behavior, but age is. The estimated odds ratio for bf for two children who differ by one year in age is 0.86, 95%CI: [0.83, 0.88]

Assess the model fit

```
. predict bffitar1
(option mu assumed; exp(xb)/(1+exp(xb)))

. sort age

. gr bfbinjg bfbinsm bffitar1 age,c(.ll) s(oii) ylab
```



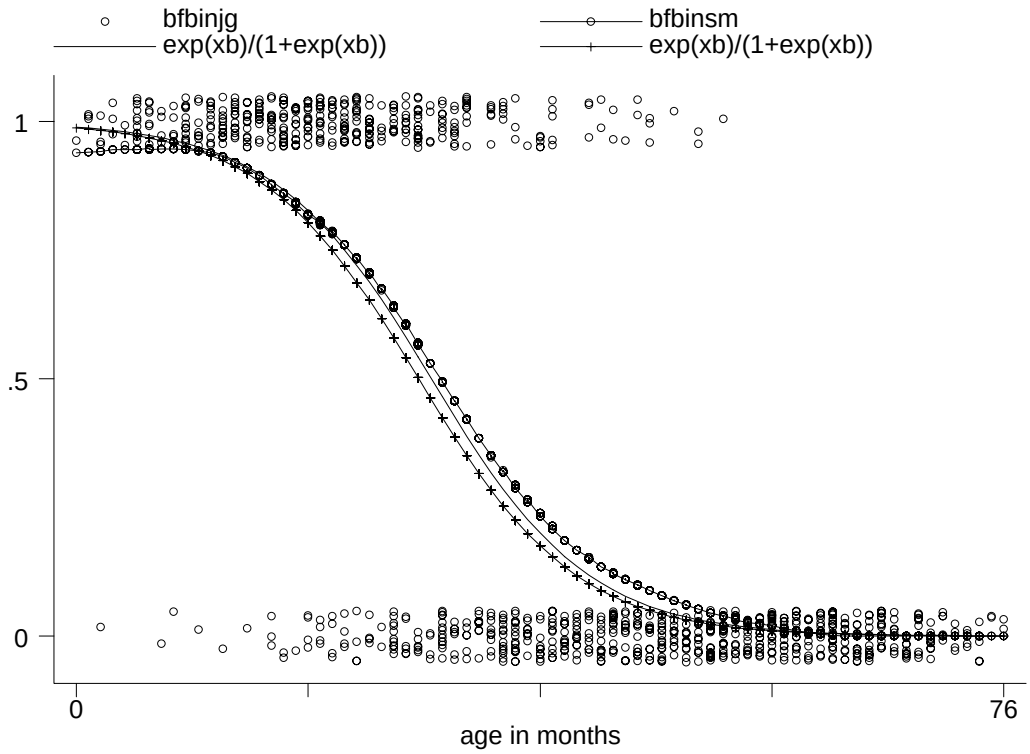
Fit GEE with uniform corr model

```
. xtgee bfbin sex age agesex, f(bin) link(logit) corr(exc) nolog

GEE population-averaged model                Number of obs     =     1000
Group variable:                      id     Number of groups  =      200
Link:                             logit     Obs per group: min =        5
Family:                         binomial                 avg =      5.0
Correlation:                exchangeable                 max =        5
                                          Wald chi2(3)      =   152.54
Scale parameter:                     1     Prob > chi2       =   0.0000

------------------------------------------------------------------------------
      bfbin |     Coef.   Std. Err.      z    P>|z|    [95% Conf. Interval]
------------+-----------------------------------------------------------------
        sex |  -.7438961   .7987586    -0.93   0.352    -2.309434    .8216421
        age |  -.1928599   .0405235    -4.76   0.000    -.2722845   -.1134352
     agesex |   .0248351   .0252077     0.99   0.325    -.0245711    .0742413
      _cons |   5.468235   1.284332     4.26   0.000     2.95099    7.985481
------------------------------------------------------------------------------

. xtgee bfbin age , f(bin) link(logit) corr(exc) nolog

GEE population-averaged model                Number of obs     =     1000
Group variable:                      id     Number of groups  =      200
Link:                             logit     Obs per group: min =        5
Family:                         binomial                 avg =      5.0
Correlation:                exchangeable                 max =        5
                                          Wald chi2(1)      =   150.49
Scale parameter:                     1     Prob > chi2       =   0.0000

------------------------------------------------------------------------------
      bfbin |     Coef.   Std. Err.      z    P>|z|    [95% Conf. Interval]
------------+-----------------------------------------------------------------
        age |   -.155618   .0126853   -12.27   0.000    -.1804806   -.1307553
      _cons |   4.367159   .4021635    10.86   0.000     3.578933    5.155385
------------------------------------------------------------------------------
```

***** display exponential of coefficient ******

```
. xtgee bfbin age , f(bin) link(logit) corr(exc) nolog eform

GEE population-averaged model                Number of obs     =     1000
Group variable:                      id     Number of groups  =      200
Link:                             logit     Obs per group: min =        5
Family:                         binomial                 avg =      5.0
Correlation:                exchangeable                 max =        5
                                          Wald chi2(1)      =   150.49
Scale parameter:                     1     Prob > chi2       =   0.0000

------------------------------------------------------------------------------
      bfbin | Odds Ratio   Std. Err.      z    P>|z|    [95% Conf. Interval]
------------+-----------------------------------------------------------------
        age |   .8558861   .0108571   -12.27   0.000    .8348689    .8774324
------------------------------------------------------------------------------

. predict bffitexc
(option mu assumed; exp(xb)/(1+exp(xb)))
```

```
. gr bfbinjg bfbinsm bffitar1 bffitexc age,c(.lll) s(ooip) ylab
```



. Use the unstructured option to choose a correlation structure

```
. xtgee bfbin age , f(bin) link(logit) corr(unst) nolog

GEE population-averaged model                 Number of obs     =     1000
Group and time vars:           id obsno       Number of groups  =      200
Link:                          logit       Obs per group: min =        5
Family:                      binomial                    avg =      5.0
Correlation:              unstructured                   max =        5
                                          Wald chi2(1)      =   122.86
Scale parameter:                     1    Prob > chi2       =   0.0000

------------------------------------------------------------------------------
      bfbin |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
        age |  -.1552873    .01401   -11.08   0.000    -.1827465   -.1278282
      _cons |   4.434984   .443211    10.01   0.000     3.566307    5.303662
------------------------------------------------------------------------------

. xtcorr

Estimated within-id correlation matrix R:

      c1     c2     c3     c4     c5
r1  1.0000
r2  0.4902  1.0000
r3  0.4747  0.7397  1.0000
r4  0.4191  0.6107  0.6662  1.0000
r5  0.3440  0.5264  0.5516  0.7136  1.0000
```

The unstructured std. err. estimate and the correlation matrix also suggests an ar(1) model for the correlation structure.