Logistic (RLOGIST) Example #6

SUDAAN Statements and Results Illustrated

- PRED_EFF
- PREDMARG
- EFFECTS
- SUBPOPX
- REFLEVEL

Input Data Set(s): SAMADULTED.SAS7bdat

Example

Using 2006 NHIS data, determine for white adults whether marital status interacts with gender on the occurrence of not being able to afford prescription medications, controlling for education, age, and region of country.

This example highlights the use of the EFFECTS, PREDMARG, and PRED_EFF statements in performing the following functions in models containing main effects plus interactions: 1) testing simple effects for interaction terms, 2) estimating customized odds ratios for interaction terms, 3) estimating predicted marginal proportions (model-adjusted risks), 4) estimating model-adjusted relative risks, and 5) estimating and testing risk differences.

This example also adds 95% confidence limits to the predicted marginal proportions.

Solution

NHIS is an annual multipurpose health sample survey conducted by the National Center for Health Statistics (NCHS). For more information about the data used in this example, see ***Section 12.7***. The 2006 NHIS collected data on approximately 29,200 households; 29,900 families; 75,700 persons; 24,275 sample adults; and 9,800 sample children.

In the 2006 study, each sample adult was asked (variable AHCAFYR1):

"*During the PAST 12 MONTHS, was there any time when you needed prescription medicine but didn't get it because you couldn't afford it*?"

Possible answer codes are yes, no, don't know, refused, and not ascertained. Only 0.96% of sample adults were coded as something other than yes or no. The constructed variable CANTAFMEDS is created from AHCAFYR1 and is coded as 1=*yes* (could not afford at least once in the past 12 months) or 0=*no* (event did not happen). All other responses are coded to missing.

Example 3 uses the same dataset and shows how to perform the same functions as above in a main-effects-only model via the RLOGIST procedure. This example uses RLOGIST to model the probability that the dependent variable CANTAFMEDS is equal to 1, but fits the model with main effects plus an interaction term (*sex*marital status*). The EFFECTS, PREDMARG, and PRED_EFF statements are used to obtain estimates and tests concerning the effect of marital status at each level of gender as well as averaged over the interaction.

For variance estimation purposes, the complex sampling plan is described as 300 pseudo-strata with two pseudo-PSUs per stratum. Sampling at the first PSU stage is assumed to be with replacement. Each unit of analysis (sample adult, sample child, person, etc.) is clustered within his/her PSU, and lower level sampling units are not identified.

In this example, we use the sample adult (age 18 and older) data file with 24,275 observations. The stratification and primary sampling unit variables are named STRAT_P and PSU_P, respectively, and appear on the NEST statement. The weight variable for the sample adult file is WTFA_SA and appears on the WEIGHT statement. The PROC statements specify DESIGN=WR (*i.e.*, unequal probability sampling of PSUs with replacement), and Taylor Series linearization is used for variance estimation. The subpopulation is defined as white (MRACRPI2=1) and at least 25 years old (AGE_P >= 25).

The MODEL statement of the RLOGIST program (***Exhibit 1***):

```
MODEL CANTAF01 = SEX AGE25_3 EDUC_3 REGION MARRY_3 SEX*MARRY_3;
```

identifies CANTAFMEDS as the dependent variable; it is coded as 1=*incurred event (can't afford*) and 0=*did not incur event*. Since the independent variables (SEX, AGE25_3, EDUC_3, REGION, and MARRY_3) are to be modeled as categorical, they all appear on the CLASS statement. The default Wald-*F* test is used for all tests of hypotheses.

The model terms are as follows:

- Sex (SEX: 1=Male, 2=Female);
- Age at three levels (AGE25_3: 1=25-44, 2=45-64, 3=65+);
- Education at three levels (EDUC_3: 1=HS or Less, 2=Some College, 3=College Grad);
- Region of the U.S. at four levels (REGION: 1=NE, 2=Midwest, 3=South, 4=West); and
- Marital status at three levels (MARRY_3: 1=Married, 2=Widowed, 3=Unmarried).
- Sex-by-Marital Status interaction effect (specified SEX*MARRY_3)

The SUBPOPX statement restricts the analysis to whites aged 25 years or more. The REFLEVEL statement defines the regression coefficient reference level for sex, region, and marital status to be the first level of each variable (REFLEVEL is used for continuity with ***Example 3***; it serves no key function in this example, and it could have been removed). Since age and education are not included on the REFLEVEL statement, the last level of each of these variables will be used as the reference level for estimating regression coefficients.

The EFFECTS, PREDMARG, and PRED_EFF statements in ***Exhibit 1*** are used to obtain estimates and tests concerning the effect of marital status at each level of gender as well as averaged over the interaction cells. The EFFECTS statement is used to compute contrasts involving regression coefficients. We use the EFFECTS statement to evaluate the effect of marital status (overall effect, and unmarried vs. married) on not being able to afford prescription medicine under the following conditions:

1. When Sex=1 (Males)
2. When Sex=2 (Females)
3. At the reference level of Sex (1=Males)
4. Averaged over the interaction cells with Sex

The EXP option tells SUDAAN to exponentiate the EFFECTS contrast among regression coefficients. This yields the odds of incurring the event for unmarried vs. married, separately for males and females, and then averaged over the interaction cells. The EXP estimates are the *user-defined odds ratios*.

```
EFFECTS MARRY_3 / SEX=1 NAME="Married Effect: Males";
EFFECTS MARRY_3 / SEX=2 NAME="Married Effect: Females";
EFFECTS MARRY_3 / REFLEVEL NAME="Married Effect: SEX=Reflevel";
EFFECTS MARRY_3 / AVERAGE NAME="Married Effect: averaged";

EFFECTS MARRY_3=(-1 0 1) / SEX=1 EXP
                           NAME="Unmarried vs Married, Males";
EFFECTS MARRY_3=(-1 0 1) / SEX=2 EXP
                           NAME="Unmarried vs Married, Females";
EFFECTS MARRY_3=(-1 0 1) / REFLEVEL EXP
                           NAME="Unmarried vs Married, Reflevel";
EFFECTS MARRY_3=(-1 0 1) / AVERAGE EXP
                           NAME="Unmarried vs Married, Averaged";
```

The PREDMARG statement requests the predicted marginal proportion (*model-adjusted risk*) for each cross-classified level of SEX*MARRY_3. The ADJRR option on the PREDMARG statement computes the ratio of predicted marginal proportions (*model-adjusted risk ratio*) for each marital status group (2=widowed, 3=unmarried) compared to the user-specified reference level (1=married), separately for males and females.

```
    PREDMARG SEX(1)*MARRY_3(1) / adjrr;
    PREDMARG SEX(2)*MARRY_3(1) / adjrr;
```

The first two PRED_EFF statements compute the difference in predicted marginal proportions (*risk differences*) for Unmarried vs. Married adults, separately for males and females. The third PRED_EFF statement computes the difference of differences—to determine if the marriage effect for males is significantly different from the marriage effect for females.

```
PRED_EFF SEX=(1 0)*MARRY_3=(-1 0 1) /
                        name="Unmarried vs Married, Males";
PRED_EFF SEX=(0 1)*MARRY_3=(-1 0 1) /
                        name="Unmarried vs Married, Females";
PRED_EFF SEX=(1 -1)*MARRY_3=(-1 0 1) /
                        name="Unmarried vs Married, M vs F";
```

We include multiple PRINT statements, all optional. Multiple PRINT statements allow us to set up different default print environments (SETENV statements) for different PRINT groups. The PRINT statements are used in this example to request the PRINT groups of interest, to specify a variety of formats for those printed statistics, and in some cases, to change the default label for the statistic. Without the PRINT statements, default statistics are produced from each PRINT group, with default formats and labels.

The SETENV statements are optional. They set up default formats for printed statistics and further manipulate the printout to the needs of the user.

The RFORMAT statements associate the SAS formats with the variables used in the RLOGIST procedure. The RLABEL statement defines variable labels for use in the current procedure only. Without the RLABEL statement, SAS variable labels would be produced if already defined.

This example was run in SAS-Callable SUDAAN, and the SAS program and *.LST files are provided.

Exhibit 1. SAS-Callable SUDAAN Code

```
libname in "c:\10winbetatest\AmJEpid";

options nocenter pagesize=70 linesize=95;
proc format;
  value educ 1="1=HS or Less"
             2="2=Some College"
             3="3=College+";
  value age 1="25-44"
            2="45-64"
            3="65+";
  value sex 1="1=Male"
            2="2=Female";
  value region 1="1=N.E."
               2="2=Midwest"
               3="3=South"
               4="4=West";
  value marry 1="1=Married"
              2="2=Widowed"
              3="3=Unmarried";
  value yesno 1="Yes"
              0="No";

Data samadult; set in.samadulted;
  if 0 le educ1 le 14 then educ_3=1;
  else if educ1=15 then educ_3=2;
  else if 16 le educ1 le 21 then educ_3=3;
  else educ_3=.;

  if 25 le age_p le 44 then age25_3=1;
  else if 45 le age_p le 64 then age25_3=2;
  else if age_p ge 65 then age25_3=3;

  if r_maritl in (1,2,3) then marry_3=1;
  else if r_maritl=4 then marry_3=2;
  else if r_maritl in (5,6,7,8) then marry_3=3;
  else marry_3=.;

  if ahcafyr1=1 then cantafmeds=1;
  else if ahcafyr1=2 then cantafmeds=0;
  else if ahcafyr1 in (7,8,9) then cantafmeds=.;

proc sort data=samadult; by strat_p psu_p;
```

Exhibit 1. SAS-Callable SUDAAN Code (continued)

```
PROC RLOGIST DATA=samadult DESIGN=WR FILETYPE=SAS;
  NEST STRAT_P PSU_P;
  WEIGHT WTFA_SA;

  SUBPOPX AGE_P>24 AND MRACRPI2=1 / NAME="WHITES AGED 25+";
  CLASS SEX AGE25_3 EDUC_3 REGION MARRY_3;

  REFLEVEL SEX=1 REGION=1 MARRY_3=1;
  MODEL CANTAFMEDS = SEX AGE25_3 EDUC_3 REGION MARRY_3 SEX*MARRY_3;

  EFFECTS MARRY_3 / SEX=1 NAME="Married Effect: Males";
  EFFECTS MARRY_3 / SEX=2 NAME="Married Effect: Females";
  EFFECTS MARRY_3 / REFLEVEL NAME="Married Effect: SEX=Reflevel";
  EFFECTS MARRY_3 / AVERAGE NAME="Married Effect: averaged";

  EFFECTS MARRY_3=(-1 0 1) / SEX=1 EXP NAME="Unmarried vs Married, Males";
  EFFECTS MARRY_3=(-1 0 1) / SEX=2 EXP NAME="Unmarried vs Married, Females";
  EFFECTS MARRY_3=(-1 0 1) / REFLEVEL EXP NAME="Unmarried vs Married, Reflevel";
  EFFECTS MARRY_3=(-1 0 1) / AVERAGE EXP NAME="Unmarried vs Married, Averaged";

  PREDMARG SEX(1)*MARRY_3(1) / adjrr;
  PREDMARG SEX(2)*MARRY_3(1) / adjrr;

  PRED_EFF SEX=(1 0)*MARRY_3=(-1 0 1) / name="Unmarried vs Married, Males";
  PRED_EFF SEX=(0 1)*MARRY_3=(-1 0 1) / name="Unmarried vs Married, Females";
  PRED_EFF SEX=(1 -1)*MARRY_3=(-1 0 1) / name=”Unmarried vs Married, M vs F”;

  setenv labwidth=24 colspce=1;
  print / betas=default
          betafmt=f7.4 sebetafmt=f8.4 lowbetafmt=f7.4 upbetafmt=f7.4
          t_betafmt=f6.2 p_betafmt=f7.4 ;

  setenv labwidth=30 colspce=4 decwidth=3;
  print / risk=default tests=default expcntrst=default waldffmt=f7.2
          waldpfmt=f7.4 dffmt=f7.0 loworfmt=f9.3 uporfmt=f9.3 low_cntrstfmt=f9.3
          up_cntrstfmt=f9.3;

  setenv labwidth=24 decwidth=4 colwidth=6 colspce=2;
  print predmrg="PREDMARG" / pred_mrg=default predmrgfmt=f8.4 t_prdmrgfmt=f8.2
                             p_prdmrgfmt=f7.4;

  setenv labwidth=35 decwidth=4 colwidth=8 colspce=2;
  print / prmgcons=default t_pmconfmt=f8.2;

  setenv labwidth=40 decwidth=3 colwidth=9 colspce=3;
  print / predrisk=default pred_rrfmt=f8.3;

  RLABEL age25_3="Age Group";
  RLABEL cantafmeds="Can't Afford Meds Past 12m";
  RFORMAT sex sex.;
  RFORMAT age25_3 age.;
  RFORMAT educ_3 educ.;
  RFORMAT region region.;
  RFORMAT marry_3 marry.;
  RFORMAT sex sex.;

  RTITLE "Modelling Can't Afford Rx Meds (Interaction Model)";
  RFOOTNOTE "Data Source: NCHS National Health Interview Survey (2006)" ;
```

Exhibit 2. First Page of SUDAAN Output (SAS *.LST File)

```
                                 S U D A A N
            Software for the Statistical Analysis of Correlated Data
          Copyright      Research Triangle Institute     February 2011
                               Release 11.0.0


DESIGN SUMMARY: Variances will be computed using the Taylor Linearization Method, Assuming a
With Replacement (WR) Design
    Sample Weight: WTFA_SA
    Stratification Variables(s): STRAT_P
    Primary Sampling Unit: PSU_P


Number of zero responses     : 14737
Number of non-zero responses :  1305

Independence parameters have converged in 7 iterations

Number of observations read       :  24275    Weighted count:220266693
Observations in subpopulation     :  16469    Weighted count:158409519
Observations used in the analysis :  16042    Weighted count:154637709
Denominator degrees of freedom    :    300


Maximum number of estimable parameters for the model is 13

File SAMADULT contains  600 Clusters
 596 clusters were used to fit the model
Maximum cluster size is  71 records
Minimum cluster size is   1 records


Sample and Population Counts for Response Variable CANTAFMEDS
Based on observations used in the analysis
0:  Sample Count    14737    Population Count 142746051
1:  Sample Count     1305    Population Count  11891658

R-Square for dependent variable CANTAFMEDS (Cox & Snell, 1989): 0.036493

-2 * Normalized Log-Likelihood with Intercepts Only :  8699.01
-2 * Normalized Log-Likelihood Full Model           :  8102.64
Approximate Chi-Square (-2 * Log-L Ratio)           :   596.37
Degrees of Freedom                                  :       12

Note: The approximate Chi-Square is not adjusted for clustering.
      Refer to hypothesis test table for adjusted test.
```

Exhibit 2 indicates that 24,275 observations were read in; 16,469 are in the subpopulation defined as white adults over the age of 25; and 16,042 observations were used in the analysis (due to missing values for one or more model variables). The CLASS variable frequencies were generated but are not displayed here.

Exhibit 3. Regression Coefficients Table

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Independent Variables and Effects.
--------------------------------------------------------------------------------
Independent Variables                           Lower     Upper
  and Effects                                   95%       95%                P-value
                        Beta                    Limit     Limit     T-Test   T-Test
                        Coeff.     SE Beta      Beta      Beta      B=0      B=0
--------------------------------------------------------------------------------
Intercept               -5.0464     0.2031   -5.4461   -4.6467   -24.85    0.0000
Sex
  1=Male                 0.0000     0.0000    0.0000    0.0000      .         .
  2=Female               0.3911     0.1119    0.1708    0.6114     3.49    0.0005
Age Group
  25-44                  1.2653     0.1511    0.9679    1.5628     8.37    0.0000
  45-64                  1.1822     0.1422    0.9024    1.4621     8.31    0.0000
  65+                    0.0000     0.0000    0.0000    0.0000      .         .
EDUC_3
  1=HS or Less           0.8969     0.0808    0.7379    1.0560    11.10    0.0000
  2=Some College         0.8882     0.1027    0.6860    1.0904     8.65    0.0000
  3=College+             0.0000     0.0000    0.0000    0.0000      .         .
Region
  1=N.E.                 0.0000     0.0000    0.0000    0.0000      .         .
  2=Midwest              0.3453     0.1271    0.0951    0.5954     2.72    0.0070
  3=South                0.5051     0.1262    0.2568    0.7533     4.00    0.0001
  4=West                 0.3563     0.1381    0.0845    0.6281     2.58    0.0104
MARRY_3
  1=Married              0.0000     0.0000    0.0000    0.0000      .         .
  2=Widowed              0.7494     0.3283    0.1033    1.3955     2.28    0.0231
  3=Unmarried            0.6162     0.1167    0.3866    0.8458     5.28    0.0000
Sex, MARRY_3
  1=Male, 1=Married      0.0000     0.0000    0.0000    0.0000      .         .
  1=Male, 2=Widowed      0.0000     0.0000    0.0000    0.0000      .         .
  1=Male, 3=Unmarried    0.0000     0.0000    0.0000    0.0000      .         .
  2=Female, 1=Married    0.0000     0.0000    0.0000    0.0000      .         .
  2=Female, 2=Widowed   -0.4840     0.3528   -1.1782    0.2102    -1.37    0.1711
  2=Female, 3=Unmarried  0.3210     0.1418    0.0420    0.6001     2.26    0.0243
--------------------------------------------------------------------------------Data Source:
NCHS National Health Interview Survey (2006)
```

Care is needed in interpreting the regression coefficients for any main effect in the presence of an interaction term containing that effect (see ***Exhibit 3***). For example, the effect of Marital Status=3 vs. 1 (Unmarried vs. Married) is significant (β=0.6162, *p*=0.0000), but this corresponds to SEX at its specified reference cell (males, in accordance with REFLEVEL statement). Among males, the Unmarried group has an increased likelihood of incurring the event compared to the Married group.

The EFFECTS statement makes it easier to test the effect of marital status at any level of sex, or even averaged over the cells of the interaction with sex.

Exhibit 4. ANOVA Table and EFFECTS Contrasts

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Contrast.
------------------------------------------------------------
Contrast                         Degrees
                                 of                   P-value
                                 Freedom    Wald F    Wald F
------------------------------------------------------------
OVERALL MODEL                         13    333.02    0.0000
MODEL MINUS INTERCEPT                 12     39.50    0.0000
INTERCEPT                              .         .       .
SEX                                    .         .       .
AGE25_3                                2     37.62    0.0000
EDUC_3                                 2     64.83    0.0000
REGION                                 3      5.39    0.0013
MARRY_3                                .         .       .
SEX * MARRY_3                          2      4.32    0.0142
Married Effect: Males                  2     15.07    0.0000
Married Effect: Females                2     63.59    0.0000
Married Effect: SEX=Reflevel           2     15.07    0.0000
Married Effect: averaged               2     58.99    0.0000
Unmarried vs Married, Males            1     27.89    0.0000
Unmarried vs Married, Females          1    124.67    0.0000
Unmarried vs Married, Reflevel         1     27.89    0.0000
Unmarried vs Married, Averaged         1    117.40    0.0000
------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

In the ANOVA table (***Exhibit 4***), SUDAAN provides the test for each term in the model by default. The SEX*MARRY_3 interaction term is significant (*p*=0.0142). This means that the marital status effect is significantly different for males vs. females.

The EFFECTS statement contrasts are contained in the last 8 rows of the table and are generated by the following statements from ***Exhibit 1***:

```
EFFECTS MARRY_3 / SEX=1 NAME="Married Effect: Males";
EFFECTS MARRY_3 / SEX=2 NAME="Married Effect: Females";
EFFECTS MARRY_3 / REFLEVEL NAME="Married Effect: SEX=Reflevel";
EFFECTS MARRY_3 / AVERAGE NAME="Married Effect: averaged";

EFFECTS MARRY_3=(-1 0 1) / SEX=1 EXP
                           NAME="Unmarried vs Married, Males";
EFFECTS MARRY_3=(-1 0 1) / SEX=2 EXP
                           NAME="Unmarried vs Married, Females";
EFFECTS MARRY_3=(-1 0 1) / REFLEVEL EXP
                           NAME="Unmarried vs Married, Reflevel";
EFFECTS MARRY_3=(-1 0 1) / AVERAGE EXP
                           NAME="Unmarried vs Married, Averaged";
```

We see from ***Exhibit 4*** that the overall effect of marital status (2 df) on being able to afford prescription medicine is significant for males, females, and when averaged over the interaction with sex. It is also significant at the reference level for SEX, which in this example refers to males. Therefore, the effect of marital status is the same when SEX=1 or the REFLEVEL option is specified. The 1 df test for comparing Unmarried vs. Married is significant for Males, Females, REFLEVEL (same as males), and when averaged over the interaction. Judging by the magnitude of the Wald *F* statistics, the effect of marital status on the ability to afford prescription medicine is larger among females than males.

Exhibit 5. Default Odds Ratios

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Independent Variables and Effects.
```

Independent Variables and Effects	Odds Ratio	Lower 95% Limit OR	Upper 95% Limit OR
Intercept	0.006	0.004	0.010
Sex			
1=Male	1.000	1.000	1.000
2=Female	1.479	1.186	1.843
Age Group			
25-44	3.544	2.632	4.772
45-64	3.262	2.465	4.315
65+	1.000	1.000	1.000
EDUC_3			
1=HS or Less	2.452	2.092	2.875
2=Some College	2.431	1.986	2.975
3=College+	1.000	1.000	1.000
Region			
1=N.E.	1.000	1.000	1.000
2=Midwest	1.412	1.100	1.814
3=South	1.657	1.293	2.124
4=West	1.428	1.088	1.874
MARRY_3			
1=Married	1.000	1.000	1.000
2=Widowed	2.116	1.109	4.037
3=Unmarried	1.852	1.472	2.330
Sex, MARRY_3			
1=Male, 1=Married	1.000	1.000	1.000
1=Male, 2=Widowed	1.000	1.000	1.000
1=Male, 3=Unmarried	1.000	1.000	1.000
2=Female, 1=Married	1.000	1.000	1.000
2=Female, 2=Widowed	0.616	0.308	1.234
2=Female, 3=Unmarried	1.379	1.043	1.822

Data Source: NCHS National Health Interview Survey (2006)

The default odds ratios table (***Exhibit 1***) should also be interpreted with caution when interaction effects are present. For example, the odds ratio for Unmarried vs. Married is 1.852, but since a sex-by-marital status interaction is present, the odds ratio is for SEX at its reference level (males). So we know there is a 85% increase in odds of not being able to afford prescription medicine for Unmarried white men compared to Married white men.

The EXP option on the EFFECTS statement (results presented next) is used to give us the odds ratio for females. We will be able to tell if the interaction is due to a difference in the magnitude of the marital status effect for males vs. females, or if the marital status effect changes direction for males vs. females. Significant interaction can result from either of these situations.

The user-specified odds ratios are generated by the EXP option on the EFFECTS statements in ***Exhibit 1***:

```
EFFECTS MARRY_3=(-1 0 1) / SEX=1 EXP
                           NAME="Unmarried vs Married, Males";
EFFECTS MARRY_3=(-1 0 1) / SEX=2 EXP
                           NAME="Unmarried vs Married, Females";
EFFECTS MARRY_3=(-1 0 1) / REFLEVEL EXP
                           NAME="Unmarried vs Married, Reflevel";
EFFECTS MARRY_3=(-1 0 1) / AVERAGE EXP
                           NAME="Unmarried vs Married, Average";
```

Exhibit 6. User-Specified Odds Ratios (EXP Option on EFFECTS)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Contrast.
----------------------------------------------------------------------
Contrast                                        Lower 95%   Upper 95%
                                 EXP(Contrast)  Limit       Limit
----------------------------------------------------------------------
Unmarried vs Married, Males              1.852       1.472       2.330
Unmarried vs Married, Females            2.553       2.164       3.011
Unmarried vs Married, Reflevel           1.852       1.472       2.330
Unmarried vs Married, Averaged           2.185       1.896       2.519
----------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

From ***Exhibit 6***, we see that the odds ratio (for occurrence of can't afford prescription medications, past 12 months) for Unmarried vs. Married is significantly greater than 1.0 but higher in females (2.553) vs. males (1.852). Both values show increased likelihood for Unmarried vs. Married and neither contain the null value of 1.0. In addition, the confidence limits do not show much overlap, and hence the significant interaction.

Unmarried white women over 25 yrs of age are two and a half times more likely to incur the event than Married women in the same subpopulation. The male odds ratio of 1.852 also appeared in the table of default odds ratios. Unmarried white men over 25 yrs of age are less than twice as likely as Married men in the same subpopulation to incur the event.

The odds ratio for Unmarried vs. Married when the interacting variable SEX is at its reference cell defaults to males. Recall that the reference cell is either the default last level of the categorical variable, unless a different reference cell is specified on the REFLEVEL statement. In this example, the REFLEVEL statement specifies males as the reference cell for SEX when fitting the model, so the REFLEVEL option on the EFFECTS statement defaults to males. Finally, the odds ratio for Unmarried vs Married when averaged over the interaction cells (SEX)=2.185. This value is midway between that for males and females.

Next, we present the model-adjusted risks (via predicted marginal proportions) for the cross-classification of sex-by-marital status. Note that the values in parentheses and the ADJRR option are related to estimating risk ratios and are <u>not</u> needed to produce marginals.

```
PREDMARG SEX(1)*MARRY_3(1) / adjrr;
PREDMARG SEX(2)*MARRY_3(1) / adjrr;
```

Exhibit 7. Predicted Marginal Proportions (Model-Adjusted Risks)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Predicted Marginal #1.
--------------------------------------------------------------------------------
Predicted Marginal #1                           Lower    Upper
                                                95%      95%
                         PREDMARG       SE      Limit    Limit   T:Marg=0   P-value
--------------------------------------------------------------------------------
Sex, MARRY_3
  1=Male, 1=Married        0.0476   0.0041   0.0401   0.0564     11.51    0.0000
  1=Male, 2=Widowed        0.0944   0.0265   0.0537   0.1608      3.57    0.0004
  1=Male, 3=Unmarried      0.0839   0.0064   0.0720   0.0974     13.04    0.0000
  2=Female, 1=Married      0.0684   0.0041   0.0608   0.0769     16.81    0.0000
  2=Female, 2=Widowed      0.0869   0.0134   0.0640   0.1171      6.51    0.0000
  2=Female, 3=Unmarried    0.1543   0.0073   0.1404   0.1693     21.05    0.0000
--------------------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

Exhibit 7 suggests that the risk for not being able to afford prescription medicine is higher in general among females than males. Both sexes show increases in risk for Widowed and Unmarried vs. Married. The significant interaction appears to result from a larger marital status effect in females vs. males.

Exhibit 7 also contains the 95% confidence limits for the predictive margins. The non-overlapping confidence intervals for Unmarried vs. Married points to significant differences between these groups.

Next, we present the model-adjusted risk ratios. The ADJRR option on the PREDMARG statement computes the ratio of predicted marginal proportions (*model-adjusted risk ratio*) for each marital status group (2=Widowed, 3=Unmarried) compared to the user-specified reference level (1=Married), separately for males and females. Note that the REFLEVEL statement has no effect in determining reference levels for risk ratios. Reference levels for risk ratios are by default the last level of each variable, unless a different level is specified in parentheses by the user. We specified MARRY_3(1) (*i.e.*, married) to be the reference cell in each case.

Exhibit 8. Model-Adjusted Risk Ratios (Reference Cell=Male)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Predicted Marginal Risk Ratio #1.
-------------------------------------------------------------------------------
Predicted Marginal Risk Ratio #1     PREDMARG
                                     Risk                Lower 95%   Upper 95%
                                     Ratio          SE   Limit       Limit
-------------------------------------------------------------------------------
MARRY_3=1=Married
  SEX: 2=Female vs. 1=Male              1.437    0.150       1.171       1.764

SEX=1=Male
  MARRY_3: 2=Widowed vs. 1=Married      1.983    0.577       1.119       3.515
  MARRY_3: 3=Unmarried vs. 1=Married    1.762    0.189       1.426       2.176
-------------------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

Exhibit 9. Model-Adjusted Risk Ratios (Reference Cell=Female)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Predicted Marginal Risk Ratio #2.
-------------------------------------------------------------------------------
Predicted Marginal Risk Ratio #2     PREDMARG
                                     Risk                Lower 95%   Upper 95%
                                     Ratio          SE   Limit       Limit
-------------------------------------------------------------------------------
MARRY_3=1=Married
  SEX: 1=Male vs. 2=Female              0.696    0.072       0.567       0.854

SEX=2=Female
  MARRY_3: 2=Widowed vs. 1=Married      1.271    0.204       0.927       1.743
  MARRY_3: 3=Unmarried vs. 1=Married    2.256    0.165       1.953       2.606
-------------------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

The last line in each table is of main interest in this example. The estimated risk ratio for Unmarried vs. Married is 1.76 for males, 2.26 for females. These values are similar to the odds ratios in this example.

Again, we see that the effect of Unmarried vs. Married is greater for females than for males. Unmarried white women over 25 yrs of age are more than twice as likely as Married white women to have difficulty affording prescription medicine. At the same time, Married white men over 25 yrs of age are less than twice as likely as Unmarried white men to incur the event.

The first two PRED_EFF statements compute the difference in predicted marginal proportions (*risk differences*) for Unmarried vs. Married adults, separately for males and females. The third PRED_EFF statement computes the difference of differences—to determine if the marriage effect for males is significantly different from the marriage effect for females.

```
PRED_EFF SEX=(1 0)*MARRY_3=(-1 0 1) /
                        name="Unmarried vs Married, Males";
PRED_EFF SEX=(0 1)*MARRY_3=(-1 0 1) /
                        name="Unmarried vs Married, Females";
PRED_EFF SEX=(1 -1)*MARRY_3=(-1 0 1) /
                        name="Unmarried vs Married, M vs F";
```

Exhibit 10. Risk Differences (Unmarried vs. Married, Males)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Contrasted Predicted Marginal #1.
-------------------------------------------------------------------------------
Contrasted Predicted Marginal #1
                                      PREDMARG
                                      Contrast         SE     T-Stat    P-value
-------------------------------------------------------------------------------
Unmarried vs Married, Males             0.0363     0.0071       5.08     0.0000
-------------------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

The above output (***Exhibit 10***) is the estimated risk difference for males. There is an absolute difference in risk of 3.63% (p=0.0000) for Unmarried vs. Married males.

Exhibit 11. Risk Differences (Unmarried vs. Married, Females)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Contrasted Predicted Marginal #2.
-------------------------------------------------------------------------------
Contrasted Predicted Marginal #2
                                      PREDMARG
                                      Contrast         SE     T-Stat    P-value
-------------------------------------------------------------------------------
Unmarried vs Married, Females           0.0859     0.0081      10.59     0.0000
-------------------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

The above output (***Exhibit 11***) is the estimated risk difference for females. There is an absolute difference in risk of 8.59% for Unmarried vs. Married females (*p*=0.0000). So the estimated risk difference for Unmarried vs. Married is higher among females (8.59%) than among males (3.63%).

Exhibit 12. Risk Differences (Marriage Effect, Males vs. Females)

```
Variance Estimation Method: Taylor Series (WR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable CANTAFMEDS: Can't Afford Meds Past 12m
For Subpopulation: WHITES AGED 25+

Modelling Can't Afford Rx Meds (Interaction Model)

by: Contrasted Predicted Marginal #3.
-------------------------------------------------------------------------------
Contrasted Predicted Marginal #3
                                      PREDMARG
                                      Contrast         SE     T-Stat    P-value
-------------------------------------------------------------------------------
Unmarried vs Married, M vs F           -0.0497     0.0107      -4.64     0.0000
-------------------------------------------------------------------------------
Data Source: NCHS National Health Interview Survey (2006)
```

The above output (***Exhibit 12***) is the estimated difference of risk differences—that is, the marriage effect (Unmarried vs. Married) for males minus females. The difference of differences is computed from 3.63% - 8.59% = -4.97% (*p*=0.0000). So the marriage effect on the risk of not being able to afford prescription medications in the past year is significantly higher in females compared to males.