CHAPTER 11 ASDA ANALYSIS EXAMPLES REPLICATION

GENERAL NOTES ABOUT ANALYSIS EXAMPLES REPLICATION

These examples are intended to provide guidance on how to use the commands/procedures for analysis of complex sample survey data and assume all data management and other preliminary work is done. The relevant syntax for the procedure of interest is shown first along with the associated output for that procedure(s). In some examples, there may be more than one block of syntax and in this case all syntax is first presented followed by the output produced.

In some software packages certain procedures or options are not available but we have made every attempt to demonstrate how to match the output produced by Stata 10+ in the textbook. Check the ASDA website for updates to the various software tools we cover.

GENERAL NOTES ON MULTIPLE IMPUTATION IN SAS V9.2

SAS v9.2 offers two procedures for multiple imputation and analysis of imputed data sets: PROC MI/PROC MIANALYZE. One of the complexities in using SAS for multiple imputation is the way it handles class variables and the methods for imputation required for imputation with/to class variables. The general rule is that you must have a monotone missing data pattern for imputation using class variables. This often requires a 2 step imputation process where the first step imputes just enough missing data to produce a monotone missing data pattern and then the 2nd imputation fills in the remaining missing data using an appropriate method for the types of variables to be imputed.

NHANES data are used for these examples with filters to restrict cases to those age 18+ and with a non-zero weight on the Medical Examination data, n=5334. In this example, a monotone missing data pattern is produced by using the MCMC method to impute MARCAT and some cases with missing data on BMXBMI, BPXDI1_1 and INCFMPRI. The 2nd step then uses the regression method to impute the remaining missing data on the continuous variables BPXDI1_1, BMXBMI and INCFMPIR.

Once the imputations are complete, the imputed data sets are then analyzed with standard SAS Survey Procedures and finally PROC MIANALYZE. SAS has the ability to read in the correct information from the Survey procedures into PROC MIANALYZE and thus account for both the complex sample survey data as well as the variability introduced by the imputation process.

The results of these processes are very similar to but not exactly the same as the Stata 10.1: ice and mim commands, due to differing imputation methods and assumptions. Please refer to the SAS and Stata documentation for details and formulae.

```
* examine missing data patterns for variables of interest;
proc mi nimpute=0 data=c11 ;
var bpxdi1_1  riagendr ridreth1 agec bmxbmi indfmpir marcat ;
run ;
```

The SAS System

The MI Procedure

Model Information

Data Set	WORK.C11
Method	MCMC
Multiple Imputation Chain	Single Chain
Initial Estimates for MCMC	EM Posterior Mode
Start	Starting Value
Prior	Jeffreys
Number of Imputations	0
Number of Burn-in Iterations	200
Number of Iterations	100
Seed for random number generator	14991001

Missing Data Patterns

Group	BPXDI1_1	RIAGENDR	RIDRETH1	AGEC	BMXBMI	INDFMPIR	MARCAT	Freq	Percent
1	X	X	X	X	X	X	X	4308	80.76
2	X	X	X	X	X	X	.	3	0.06
3	X	X	X	X	X	.	X	217	4.07
4	X	X	X	X	.	X	X	49	0.92
5	X	X	X	X	.	.	X	4	0.07
6	.	X	X	X	X	X	X	666	12.49
7	.	X	X	X	X	X	.	1	0.02
8	.	X	X	X	X	.	X	41	0.77
9	.	X	X	X	X	.	.	1	0.02
10	.	X	X	X	.	X	X	39	0.73
11	.	X	X	X	.	.	X	5	0.09

Missing Data Patterns

	Group Means						
Group	BPXDI1_1	RIAGENDR	RIDRETH1	AGEC	BMXBMI	INDFMPIR	MARCAT
1	69.092851	1.517874	2.873027	-0.978618	28.423888	2.622560	1.636955
2	74.000000	1.666667	3.000000	18.402070	22.776667	2.133333	.
3	67.105991	1.506912	2.447005	2.259212	27.698111	.	1.764977
4	69.387755	1.489796	2.918367	17.544926	.	2.117347	1.693878
5	57.000000	1.250000	2.500000	17.902069	.	.	2.000000
6	.	1.533033	2.990991	-0.603937	29.304339	2.454414	1.753754
7	.	1.000000	3.000000	12.402070	30.870001	2.220000	.
8	.	1.634146	2.536585	-2.719882	29.691463	.	1.878049
9	.	2.000000	3.000000	39.402069	23.280001	.	.
10	.	1.512821	3.179487	9.940531	.	2.251538	1.589744
11	.	1.600000	3.600000	20.802069	.	.	2.200000

```
*Step one is to use the MCMC method to impute enough data to acheive a monotone missing data pattern:
        this is required for categorical variables (for use of class statement), note that order of variables in var statement will
dictate which variables are imputed in this step ;

proc mi data=c11
        nimpute=5
        seed=44
        out=outimputed_monotone ;
        var marcat riagendr ridreth1 agec bpxdi1_1 bmxbmi indfmpir ;
        mcmc impute=monotone ;
run ;
```

The SAS System
The MI Procedure
Model Information

Data Set	WORK.C11
Method	Monotone-data MCMC
Multiple Imputation Chain	Single Chain
Initial Estimates for MCMC	EM Posterior Mode
Start	Starting Value
Prior	Jeffreys
Number of Imputations	5
Number of Burn-in Iterations	200
Number of Iterations	100
Seed for random number generator	44

Missing Data Patterns

Group	MARCAT	RIAGENDR	RIDRETH1	AGEC	BPXDI1_1	BMXBMI	INDFMPIR	Freq	Percent
1	X	X	X	X	X	X	X	4308	80.76
2	X	X	X	X	X	X	0	217	4.07
3	X	X	X	X	X	.	X	49	0.92
4	X	X	X	X	X	0	0	4	0.07
5	X	X	X	X	.	X	X	666	12.49
6	X	X	X	X	.	X	0	41	0.77
7	X	X	X	X	.	.	X	39	0.73
8	X	X	X	X	0	0	0	5	0.09
9	.	X	X	X	X	X	X	3	0.06
10	.	X	X	X	.	X	X	1	0.02
11	.	X	X	X	.	X	0	1	0.02

Missing Data Patterns

	Group Means						
Group	MARCAT	RIAGENDR	RIDRETH1	AGEC	BPXDI1_1	BMXBMI	INDFMPIR
1	1.636955	1.517874	2.873027	-0.978618	69.092851	28.423888	2.622560
2	1.764977	1.506912	2.447005	2.259212	67.105991	27.698111	.
3	1.693878	1.489796	2.918367	17.544926	69.387755	.	2.117347
4	2.000000	1.250000	2.500000	17.902069	57.000000	.	.
5	1.753754	1.533033	2.990991	-0.603937	.	29.304339	2.454414
6	1.878049	1.634146	2.536585	-2.719882	.	29.691463	.
7	1.589744	1.512821	3.179487	9.940531	.	.	2.251538
8	2.200000	1.600000	3.600000	20.802069	.	.	.
9	.	1.666667	3.000000	18.402070	74.000000	22.776667	2.133333
10	.	1.000000	3.000000	12.402070	.	30.870001	2.220000
11	.	2.000000	3.000000	39.402069	.	23.280001	.

EM (Posterior Mode) Estimates

TYPE	_NAME_	MARCAT	RIAGENDR	RIDRETH1	AGEC	BPXDI1_1	BMXBMI	INDFMPIR
MEAN		1.659395	1.519873	2.871016	-0.507942	69.012338	28.516196	2.584544
COV	MARCAT	0.689254	0.009916	0.081180	-5.071421	-1.312372	-0.343965	-0.244666
COV	RIAGENDR	0.009916	0.249231	0.001062	-0.531924	-0.834532	0.176275	-0.029840
COV	RIDRETH1	0.081180	0.001062	1.271295	1.875873	1.464282	0.273002	0.290425
COV	AGEC	-5.071421	-0.531924	1.875873	405.171622	35.711765	7.611190	2.785753
COV	BPXDI1_1	-1.312372	-0.834532	1.464282	35.711765	165.341780	12.353179	1.697748
COV	BMXBMI	-0.343965	0.176275	0.273002	7.611190	12.353179	45.910086	-0.303768
COV	INDFMPIR	-0.244666	-0.029840	0.290425	2.785753	1.697748	-0.303768	2.580055

```
* check the remaining missing data patterns after first imputation,note monotone missing data pattern with 3 continuous variables
still to be imputed in step 2 ;
proc mi data=outimputed_monotone nimpute=0 ;
var marcat riagendr ridreth1 agec bpxdi1_1 bmxbmi indfmpir ;
run ;
```

The SAS System

The MI Procedure

Model Information

Data Set	WORK.OUTIMPUTED_MONOTONE
Method	MCMC
Multiple Imputation Chain	Single Chain
Initial Estimates for MCMC	EM Posterior Mode
Start	Starting Value
Prior	Jeffreys
Number of Imputations	0
Number of Burn-in Iterations	200
Number of Iterations	100
Seed for random number generator	830152001

Missing Data Patterns

Group	MARCAT	RIAGENDR	RIDRETH1	AGEC	BPXDI1_1	BMXBMI	INDFMPIR	Freq	Percent
1	X	X	X	X	X	X	X	25330	94.98
2	X	X	X	X	X	X	.	1295	4.86
3	X	X	X	X	X	.	.	20	0.07
4	X	X	X	X	.	.	.	25	0.09

Missing Data Patterns

	Group Means						
Group	MARCAT	RIAGENDR	RIDRETH1	AGEC	BPXDI1_1	BMXBMI	INDFMPIR
1	1.652328	1.519542	2.891433	-0.652017	69.052003	28.545501	2.592343
2	1.781223	1.528958	2.463320	1.614425	67.456523	27.996602	.
3	2.000000	1.250000	2.500000	17.902069	57.000000	.	.
4	2.200000	1.600000	3.600000	20.802069	.	.	.

```
*check imputed values on MARCAT for possible rounding prior to 2nd imputation ;
proc freq data=outimputed_monotone ;
tables marcat* _imputation_ / missing ;
run ;
```

The SAS System

The FREQ Procedure

Table of MARCAT by _Imputation_

MARCAT(1=married 2=prev married 3=never married)
Imputation(Imputation Number)

Frequency Percent Row Pct Col Pct	1	2	3	4	5	Total
0.025675953	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
0.1186249973	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
0.2079154339	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
0.4609882896	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	1 0.00
0.5692619792	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	1 0.00
0.754945749	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
0.9677690137	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
Total	5334 20.00	5334 20.00	5334 20.00	5334 20.00	5334 20.00	26670 100.00

(Continued)

The FREQ Procedure

Table of MARCAT by _Imputation_

MARCAT(1=married 2=prev married 3=never married)
Imputation(Imputation Number)

Frequency Percent Row Pct Col Pct	1	2	3	4	5	Total
1	3055 11.45 20.00 57.27	3055 11.45 20.00 57.27	3055 11.45 20.00 57.27	3055 11.45 20.00 57.27	3055 11.45 20.00 57.27	15275 57.27
1.0017219268	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	1 0.00
1.0198241141	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	1 0.00
1.0950745869	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
1.1151345752	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	1 0.00
1.1279452978	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
1.2837754571	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
Total	5334 20.00	5334 20.00	5334 20.00	5334 20.00	5334 20.00	26670 100.00

(Continued)

The FREQ Procedure

Table of MARCAT by _Imputation_

MARCAT(1=married 2=prev married 3=never married)
Imputation(Imputation Number)

Frequency Percent Row Pct Col Pct	1	2	3	4	5	Total
1.2849499082	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	1 0.00
1.4153947972	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
1.6028766503	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
1.6485186828	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
1.6615006981	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	1 0.00
1.8802569318	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
2	1033 3.87 20.00 19.37	1033 3.87 20.00 19.37	1033 3.87 20.00 19.37	1033 3.87 20.00 19.37	1033 3.87 20.00 19.37	5165 19.37
Total	5334 20.00	5334 20.00	5334 20.00	5334 20.00	5334 20.00	26670 100.00

(Continued)

The FREQ Procedure

Table of MARCAT by _Imputation_

MARCAT(1=married 2=prev married 3=never married)
Imputation(Imputation Number)

Frequency Percent Row Pct Col Pct	1	2	3	4	5	Total
2.206989633	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
2.3656821986	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	1 0.00
2.4047423813	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	1 0.00
2.8621226771	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
2.919087171	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00
3	1241 4.65 20.00 23.27	1241 4.65 20.00 23.27	1241 4.65 20.00 23.27	1241 4.65 20.00 23.27	1241 4.65 20.00 23.27	6205 23.27
3.1492027715	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 0.00 100.00 0.02	0 0.00 0.00 0.00	1 0.00
Total	5334 20.00	5334 20.00	5334 20.00	5334 20.00	5334 20.00	26670 100.00

```
* round the non-integer values of marcat produced by the first imputation step: this process uses a ranuni function to determine if
the value is rounded up or down to integer ;

data outimputed_monotone_round ;
        set outimputed_monotone;
randval=ranuni(44) ;
if marcat < 1.0 then marcat=1.0 ;
if 1.0 < marcat < 2.0 then do ;
        if randval < .5 then marcat =1  ;
        else if randval >= .5 then marcat=2 ;
end ;
if 2.0<marcat<3.0 or marcat > 3.0 then do ;
        if randval < .5 then marcat=2 ;
        else if randval >=.5 then marcat=3 ;
end ;

proc freq data=outimputed_monotone_round ;
        tables marcat*_imputation_ / missing ;
run ;
```

The SAS System

The FREQ Procedure

Table of MARCAT by _Imputation_

MARCAT(1=married 2=prev married 3=never married)
Imputation(Imputation Number)

Frequency Percent Row Pct Col Pct	1	2	3	4	5	Total
1	3060 11.47 20.01 57.37	3057 11.46 19.99 57.31	3058 11.47 20.00 57.33	3057 11.46 19.99 57.31	3059 11.47 20.01 57.35	15291 57.33
2	1033 3.87 19.98 19.37	1035 3.88 20.02 19.40	1034 3.88 20.00 19.39	1034 3.88 20.00 19.39	1033 3.87 19.98 19.37	5169 19.38
3	1241 4.65 19.98 23.27	1242 4.66 20.00 23.28	1242 4.66 20.00 23.28	1243 4.66 20.02 23.30	1242 4.66 20.00 23.28	6210 23.28
Total	5334 20.00	5334 20.00	5334 20.00	5334 20.00	5334 20.00	26670 100.00

```
* 2nd imputation imputes m=1 for remaining missing data on the continuous variables bpxdi1_1, bmxbmi and indfmpir:
        Note that min and max and round values are set to missing for all class variables as these options will not affect the
        Process, also note the use of a seed value so the imputations can be replicated;
*use of the regression method with the monotone statement specifies use of a regression imputation method for the 3 continuous
variables with missing data ;

proc mi
data=outimputed_monotone_round
nimpute=1
out=fullyimputed
seed=656
min=    .    .    .   -27  4    13    .
max=    .    .    .    39  124  130   .
round=  .    .    .    .1   .1  .1    . ;
class marcat riagendr ridreth1 ;
var marcat riagendr ridreth1 agec bpxdi1_1 bmxbmi indfmpir ;
monotone regression (bpxdi1_1=marcat riagendr ridreth1 agec ) ;
monotone regression (bmxbmi=marcat riagendr ridreth1 agec bpxdi1_1 ) ;
monotone regression (indfmpir=marcat riagendr ridreth1 agec bpxdi1_1 bmxbmi) ;
run ;
```

The SAS System

The MI Procedure

Model Information

Data Set	WORK.OUTIMPUTED_MONOTONE_ROUND
Method	Monotone
Number of Imputations	1
Seed for random number generator	656

Monotone Model Specification

Method	Imputed Variables
Regression	BPXDI1_1 BMXBMI INDFMPIR

Missing Data Patterns

Group	MARCAT	RIAGENDR	RIDRETH1	AGEC	BPXDI1_1	BMXBMI	INDFMPIR	Freq	Percent
1	X	X	X	X	X	X	X	25330	94.98
2	X	X	X	X	X	X	.	1295	4.86
3	X	X	X	X	X	.	.	20	0.07
4	X	X	X	X	.	.	.	25	0.09

Missing Data Patterns

	Group Means			
Group	AGEC	BPXDI1_1	BMXBMI	INDFMPIR
1	-0.652017	69.052003	28.545501	2.592343
2	1.614425	67.456523	27.996602	.
3	17.902069	57.000000	.	.
4	20.802069	.	.	.

```
* double check fully imputed data set ;
proc means data=fullyimputed nmiss mean min max ;
class _imputation_ ;
run ;
```

The SAS System

The MEANS Procedure

Imputation Number	N Obs	Variable	Label	N Miss	Mean	Minimum	Maximum
1	5334	RIAGENDR	gender - adjudicated	0	1.5198725	1.0000000	2.0000000
		RIDRETH1	1=mex 2=oth hisp 3=white 4=black 5=other	0	2.8710161	1.0000000	5.0000000
		INDFMPIR	family pir	0	2.5808455	-2.0922735	6.7829137
		WTMEC2YR	full sample 2 year mec exam weight	0	40813.74	1363.17	156152.18
		SDMVPSU	masked variance pseudo-psu	0	1.5050619	1.0000000	2.0000000
		SDMVSTRA	masked variance pseudo-stratum	0	50.5466817	44.0000000	58.0000000
		MARCAT	1=married 2=prev married 3=never married	0	1.6589801	1.0000000	3.0000000
		BPXDI1_1		0	68.9540947	4.0000000	124.0000000
		AGE18P		0	1.0000000	1.0000000	1.0000000
		AGEC		0	-0.5079417	-27.5979309	39.4020691
		AGECSQ		0	406.0373060	0.1616603	1552.52
		BMXBMI	body mass index (kg/m**2)	0	28.5198931	13.3599997	130.2100067
		randval		0	0.5023727	0.000018066	0.9997217
2	5334	RIAGENDR	gender - adjudicated	0	1.5198725	1.0000000	2.0000000
		RIDRETH1	1=mex 2=oth hisp 3=white 4=black 5=other	0	2.8710161	1.0000000	5.0000000
		INDFMPIR	family pir	0	2.5776450	-3.0608878	6.9038290
		WTMEC2YR	full sample 2 year mec exam weight	0	40813.74	1363.17	156152.18
		SDMVPSU	masked variance pseudo-psu	0	1.5050619	1.0000000	2.0000000
		SDMVSTRA	masked variance pseudo-stratum	0	50.5466817	44.0000000	58.0000000
		MARCAT	1=married 2=prev married 3=never married	0	1.6597300	1.0000000	3.0000000
		BPXDI1_1		0	68.9744311	4.0000000	124.0000000
		AGE18P		0	1.0000000	1.0000000	1.0000000
		AGEC		0	-0.5079417	-27.5979309	39.4020691
		AGECSQ		0	406.0373060	0.1616603	1552.52
		BMXBMI	body mass index (kg/m**2)	0	28.5068745	11.6622951	130.2100067
		randval		0	0.5034658	4.8642978E-6	0.9999374
3	5334	RIAGENDR	gender - adjudicated	0	1.5198725	1.0000000	2.0000000
		RIDRETH1	1=mex 2=oth hisp 3=white 4=black 5=other	0	2.8710161	1.0000000	5.0000000
		INDFMPIR	family pir	0	2.5902980	-2.6839734	6.4517656
		WTMEC2YR	full sample 2 year mec exam weight	0	40813.74	1363.17	156152.18
		SDMVPSU	masked variance pseudo-psu	0	1.5050619	1.0000000	2.0000000
		SDMVSTRA	masked variance pseudo-stratum	0	50.5466817	44.0000000	58.0000000
		MARCAT	1=married 2=prev married 3=never married	0	1.6595426	1.0000000	3.0000000
		BPXDI1_1		0	68.9959055	4.0000000	124.0000000
		AGE18P		0	1.0000000	1.0000000	1.0000000
		AGEC		0	-0.5079417	-27.5979309	39.4020691
		AGECSQ		0	406.0373060	0.1616603	1552.52
		BMXBMI	body mass index (kg/m**2)	0	28.5078094	11.3629242	130.2100067
		randval		0	0.4932413	0.000445371	0.9997255
4	5334	RIAGENDR	gender - adjudicated	0	1.5198725	1.0000000	2.0000000
		RIDRETH1	1=mex 2=oth hisp 3=white 4=black 5=other	0	2.8710161	1.0000000	5.0000000
		INDFMPIR	family pir	0	2.5745204	-2.4499097	6.2257588
		WTMEC2YR	full sample 2 year mec exam weight	0	40813.74	1363.17	156152.18
		SDMVPSU	masked variance pseudo-psu	0	1.5050619	1.0000000	2.0000000
		SDMVSTRA	masked variance pseudo-stratum	0	50.5466817	44.0000000	58.0000000
		MARCAT	1=married 2=prev married 3=never married	0	1.6599175	1.0000000	3.0000000
		BPXDI1_1		0	68.9492250	4.0000000	124.0000000
		AGE18P		0	1.0000000	1.0000000	1.0000000
		AGEC		0	-0.5079417	-27.5979309	39.4020691
		AGECSQ		0	406.0373060	0.1616603	1552.52
		BMXBMI	body mass index (kg/m**2)	0	28.5212127	5.4131649	130.2100067
		randval		0	0.5015473	0.000090485	0.9997097

The MEANS Procedure

Imputation Number	N Obs	Variable	Label	N Miss	Mean	Minimum	Maximum
5	5334	RIAGENDR	gender - adjudicated	0	1.5198725	1.0000000	2.0000000
		RIDRETH1	1=mex 2=oth hisp 3=white 4=black 5=other	0	2.8710161	1.0000000	5.0000000
		INDFMPIR	family pir	0	2.5878035	-1.8704580	8.2563201
		WTMEC2YR	full sample 2 year mec exam weight	0	40813.74	1363.17	156152.18
		SDMVPSU	masked variance pseudo-psu	0	1.5050619	1.0000000	2.0000000
		SDMVSTRA	masked variance pseudo-stratum	0	50.5466817	44.0000000	58.0000000
		MARCAT	1=married 2=prev married 3=never married	0	1.6593551	1.0000000	3.0000000
		BPXDI1_1		0	68.9516384	4.0000000	124.0000000
		AGE18P		0	1.0000000	1.0000000	1.0000000
		AGEC		0	-0.5079417	-27.5979309	39.4020691
		AGECSQ		0	406.0373060	0.1616603	1552.52
		BMXBMI	body mass index (kg/m**2)	0	28.5297070	3.9969566	130.2100067
		randval		0	0.5032340	0.000302244	0.9997641

```
* use fully imputed data sets (m=5) and do means analysis using PROC SURVEYMEANS ;
title "SurveyMeans Analysis of Five Imputed Data Sets" ;
proc surveymeans data=fullyimputed;
strata sdmvstra ;
cluster sdmvpsu ;
weight wtmec2yr ;
domain  _imputation_ ;
var bpxdi1_1 ;
ods output domain= outmean ;
run ;
```

SurveyMeans Analysis of Five Imputed Data Sets

The SURVEYMEANS Procedure

Data Summary

Number of Strata	15
Number of Clusters	30
Number of Observations	26670
Sum of Weights	1088502356

Statistics

Variable	N	Mean	Std Error of Mean	95% CL for Mean	
BPXDI1_1	26670	70.463121	0.275060	69.8768441	71.0493972

Domain Analysis: Imputation Number

Imputation Number	Variable	N	Mean	Std Error of Mean	95% CL for Mean	
1	BPXDI1_1	5334	70.516998	0.280569	69.9189803	71.1150160
2	BPXDI1_1	5334	70.435860	0.277088	69.8452608	71.0264601
3	BPXDI1_1	5334	70.486586	0.269964	69.9111708	71.0620009
4	BPXDI1_1	5334	70.491619	0.310392	69.8300334	71.1532050
5	BPXDI1_1	5334	70.384540	0.274123	69.8002603	70.9688193

SurveyMeans Analysis of Five Imputed Data Sets

```
* print out outmean data set for clarity of use in MIANALYZE ;
proc print data=outmean ;
run ;
```

Obs	DomainLabel	_Imputation_	VarName	N	Mean	StdErr	Lower CLMean	Upper CLMean
1	Imputation Number	1	BPXDI1_1	5334	70.516998	0.280569	69.9189803	71.1150160
2	Imputation Number	2	BPXDI1_1	5334	70.435860	0.277088	69.8452608	71.0264601
3	Imputation Number	3	BPXDI1_1	5334	70.486586	0.269964	69.9111708	71.0620009
4	Imputation Number	4	BPXDI1_1	5334	70.491619	0.310392	69.8300334	71.1532050
5	Imputation Number	5	BPXDI1_1	5334	70.384540	0.274123	69.8002603	70.9688193

```
* use PROC MIANALYZE to analyze the combined data sets (fully imputed and taking complex sample design into account) ;
proc mianalyze data=outmean ;
modeleffects mean ;
stderr stderr ;
run ;
```

The MIANALYZE Procedure

Model Information

Data Set	WORK.OUTMEAN
Number of Imputations	5

Variance Information

	Variance				Relative Increase	Fraction Missing	
Parameter	Between	Within	Total	DF	in Variance	Information	Relative Efficiency
mean	0.002796	0.079973	0.083328	2467.4	0.041953	0.041041	0.991859

Parameter Estimates

Parameter	Estimate	Std Error	95% Confidence Limits		DF	Minimum	Maximum
mean	70.463121	0.288666	69.89707	71.02917	2467.4	70.384540	70.516998

Parameter Estimates

Parameter	Theta0	t for H0: Parameter=Theta0	Pr > |t|
mean	0	244.10	<.0001

```
*create indicator variables for regression model predictors: this makes the model coding much easier for use in
PROC SURVEYREG and PROC MIANALYZE ;
data fullyimputed ;
set fullyimputed ;
* create indicator variables for regression ;
married=0 ; swd=0 ; nevermarried=0 ;
if marcat=1 then married=1 ;
else if marcat=2 then swd=1 ;
else if marcat=3 then nevermarried=1 ;

male=0 ; female=0 ;
if riagendr=1 then male=1 ;
else if riagendr=2 then female=1 ;

mex=0 ; othhis=0 ; white=0 ; black=0 ; other=0 ;
if ridreth1 =1 then mex=1 ;
else if ridreth1 =2 then othhis=1 ;
else if ridreth1=3 then white=1 ;
else if ridreth1=4 then black=1 ;
else if ridreth1=5 then other=1 ;

proc surveyreg data=fullyimputed;
strata sdmvstra ;
cluster sdmvpsu ;
weight wtmec2yr ;
by _imputation_ ;
model bpxdi1_1 = swd nevermarried female othhis white black other agec agecsq bmxbmi indfmpir / solution covb  ;
ods output       ParameterEstimates=outestimates    covb=regcovb ;
run ;
```

---------- Imputation Number=1 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Data Summary

Number of Observations	5334
Sum of Weights	217700471
Weighted Mean of BPXDI1_1	70.51700
Weighted Sum of BPXDI1_1	1.53516E10

Design Summary

Number of Strata	15
Number of Clusters	30

Fit Statistics

R-square	0.1220
Root MSE	11.6311
Denominator DF	15

Tests of Model Effects

Effect	Num DF	F Value	Pr > F
Model	11	291.58	<.0001
Intercept	1	2496.52	<.0001
swd	1	1.51	0.2384
nevermarried	1	0.30	0.5945
female	1	97.79	<.0001
othhis	1	1.32	0.2691
white	1	14.95	0.0015
black	1	11.56	0.0040
other	1	2.79	0.1156
AGEC	1	49.86	<.0001
AGECSQ	1	146.36	<.0001
BMXBMI	1	25.05	0.0002
INDFMPIR	1	0.05	0.8297

NOTE: The denominator degrees of freedom for the F tests is 15.

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	68.0406082	1.36176135	49.97	<.0001
swd	0.7474112	0.60863579	1.23	0.2384
nevermarried	-0.3441065	0.63270453	-0.54	0.5945
female	-3.1855697	0.32213176	-9.89	<.0001
othhis	1.0890209	0.94896405	1.15	0.2691
white	2.0939424	0.54163884	3.87	0.0015
black	2.4439351	0.71883323	3.40	0.0040

---------- Imputation Number=1 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
other	1.3240605	0.79264065	1.67	0.1156
AGEC	0.1046525	0.01482102	7.06	<.0001
AGECSQ	-0.0102798	0.00084970	-12.10	<.0001
BMXBMI	0.1899686	0.03795878	5.00	0.0002
INDFMPIR	-0.0268119	0.12253333	-0.22	0.8297

NOTE: The denominator degrees of freedom for the t tests is 15.

Covariance of Estimated Regression Coefficients

	Intercept	swd	nevermarried	female	othhis	white
Intercept	1.8543939689	0.0061409114	0.0338816337	-0.139289026	-0.064891042	-0.083504437
swd	0.0061409114	0.3704375307	0.0027085686	0.0978209249	0.3324002587	-0.090211258
nevermarried	0.0338816337	0.0027085686	0.4003150181	0.0465645152	-0.189983757	0.0752715149
female	-0.139289026	0.0978209249	0.0465645152	0.1037688711	0.1020766805	-0.018416103
othhis	-0.064891042	0.3324002587	-0.189983757	0.1020766805	0.9005327776	0.1505164958
white	-0.083504437	-0.090211258	0.0752715149	-0.018416103	0.1505164958	0.2933726336
black	0.1479734648	-0.025140456	-0.041800721	-0.051598424	0.3326103004	0.2396901332
other	0.0854469525	-0.021334176	-0.141836017	-0.056036143	0.2062330415	-0.00426267
AGEC	-0.001197127	-0.003871054	0.0057608581	-0.000285939	-0.007120325	0.0006669222
AGECSQ	-0.00041646	-0.000119989	-0.000374989	-0.000057392	0.00006937	-0.000105263
BMXBMI	-0.04657754	-0.002664727	-0.003794473	0.0028407758	-0.005481786	-0.001224046
INDFMPIR	-0.077460011	-0.003636243	-0.002749242	-0.000330839	0.0077627697	-0.010348052

Covariance of Estimated Regression Coefficients

	black	other	AGEC	AGECSQ	BMXBMI	INDFMPIR
Intercept	0.1479734648	0.0854469525	-0.001197127	-0.00041646	-0.04657754	-0.077460011
swd	-0.025140456	-0.021334176	-0.003871054	-0.000119989	-0.002664727	-0.003636243
nevermarried	-0.041800721	-0.141836017	0.0057608581	-0.000374989	-0.003794473	-0.002749242
female	-0.051598424	-0.056036143	-0.000285939	-0.000057392	0.0028407758	-0.000330839
othhis	0.3326103004	0.2062330415	-0.007120325	0.00006937	-0.005481786	0.0077627697
white	0.2396901332	-0.00426267	0.0006669222	-0.000105263	-0.001224046	-0.010348052
black	0.5167212071	0.2931743936	0.0006551622	-0.00015555	-0.007777512	-0.018555504
other	0.2931743936	0.6282791939	0.0010887847	0.0000842275	-0.006364474	0.0208620087
AGEC	0.0006551622	0.0010887847	0.0002196627	-5.214527E-6	0.0000324607	-0.000050453
AGECSQ	-0.00015555	0.0000842275	-5.214527E-6	7.21997E-7	0.0000110777	0.0000642283
BMXBMI	-0.007777512	-0.006364474	0.0000324607	0.0000110777	0.0014408687	0.0009456875
INDFMPIR	-0.018555504	0.0208620087	-0.000050453	0.0000642283	0.0009456875	0.015014417

---------- Imputation Number=2 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Data Summary

Number of Observations	5334
Sum of Weights	217700471
Weighted Mean of BPXDI1_1	70.43586
Weighted Sum of BPXDI1_1	1.53339E10

Design Summary

Number of Strata	15
Number of Clusters	30

Fit Statistics

R-square	0.1241
Root MSE	11.5915
Denominator DF	15

Tests of Model Effects

Effect	Num DF	F Value	Pr > F
Model	11	240.60	<.0001
Intercept	1	2560.52	<.0001
swd	1	0.57	0.4609
nevermarried	1	4.21	0.0580
female	1	62.61	<.0001
othhis	1	3.92	0.0663
white	1	14.52	0.0017
black	1	28.07	<.0001
other	1	3.26	0.0910
AGEC	1	54.08	<.0001
AGECSQ	1	112.05	<.0001
BMXBMI	1	32.00	<.0001
INDFMPIR	1	0.14	0.7182

NOTE: The denominator degrees of freedom for the F tests is 15.

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	66.7004451	1.31815017	50.60	<.0001
swd	0.5191823	0.68610313	0.76	0.4609
nevermarried	-1.3166156	0.64152958	-2.05	0.0580
female	-2.8478990	0.35991542	-7.91	<.0001
othhis	1.6317654	0.82400871	1.98	0.0663
white	2.2643456	0.59426166	3.81	0.0017
black	3.7213964	0.70238468	5.30	<.0001

---------- Imputation Number=2 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
other	1.6134672	0.89319087	1.81	0.0910
AGEC	0.1035105	0.01407620	7.35	<.0001
AGECSQ	-0.0096211	0.00090890	-10.59	<.0001
BMXBMI	0.2094385	0.03702365	5.66	<.0001
INDFMPIR	0.0507280	0.13793506	0.37	0.7182

NOTE: The denominator degrees of freedom for the t tests is 15.

Covariance of Estimated Regression Coefficients

	Intercept	swd	nevermarried	female	othhis	white
Intercept	1.7375198726	0.289491919	0.3870550231	-0.017852462	-0.053003498	-0.213757872
swd	0.289491919	0.470737505	0.0727243688	0.0352386539	0.2466133497	-0.189612255
nevermarried	0.3870550231	0.0727243688	0.4115602027	0.0189512071	-0.198939933	0.0279041896
female	-0.017852462	0.0352386539	0.0189512071	0.1295391085	0.1532187782	-0.005355415
othhis	-0.053003498	0.2466133497	-0.198939933	0.1532187782	0.678990362	-0.01983156
white	-0.213757872	-0.189612255	0.0279041896	-0.005355415	-0.01983156	0.3531469167
black	0.0679000121	-0.082131045	-0.058372179	-0.064812981	0.0810356269	0.2571978196
other	0.1654045178	-0.052636563	0.0978763474	-0.097620121	-0.148403919	0.1192888687
AGEC	0.0018279432	-0.000479146	0.0054803413	-0.001024647	-0.005457261	-0.000509412
AGECSQ	-0.000756068	-0.000229647	-0.000471409	-0.000023331	0.0001346996	-0.000089276
BMXBMI	-0.045817783	-0.008497528	-0.010678612	0.0008649327	0.0000186751	0.0045961049
INDFMPIR	-0.072310604	-0.008828915	-0.018823096	-0.015402002	0.0048442268	-0.019619004

Covariance of Estimated Regression Coefficients

	black	other	AGEC	AGECSQ	BMXBMI	INDFMPIR
Intercept	0.0679000121	0.1654045178	0.0018279432	-0.000756068	-0.045817783	-0.072310604
swd	-0.082131045	-0.052636563	-0.000479146	-0.000229647	-0.008497528	-0.008828915
nevermarried	-0.058372179	0.0978763474	0.0054803413	-0.000471409	-0.010678612	-0.018823096
female	-0.064812981	-0.097620121	-0.001024647	-0.000023331	0.0008649327	-0.015402002
othhis	0.0810356269	-0.148403919	-0.005457261	0.0001346996	0.0000186751	0.0048442268
white	0.2571978196	0.1192888687	-0.000509412	-0.000089276	0.0045961049	-0.019619004
black	0.4933442332	0.2965048656	-0.000437904	-0.000127563	-0.005424035	-0.003186282
other	0.2965048656	0.7977899385	0.0050356997	-0.000141007	-0.007652377	0.0110601642
AGEC	-0.000437904	0.0050356997	0.0001981394	-4.944783E-6	-0.000049132	0.0002003195
AGECSQ	-0.000127563	-0.000141007	-4.944783E-6	8.2609443E-7	0.0000200217	0.0000655054
BMXBMI	-0.005424035	-0.007652377	-0.000049132	0.0000200217	0.0013707507	0.000920458
INDFMPIR	-0.003186282	0.0110601642	0.0002003195	0.0000655054	0.000920458	0.0190260819

---------- Imputation Number=3 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Data Summary

Number of Observations	5334
Sum of Weights	217700471
Weighted Mean of BPXDI1_1	70.48659
Weighted Sum of BPXDI1_1	1.5345E10

Design Summary

Number of Strata	15
Number of Clusters	30

Fit Statistics

R-square	0.1204
Root MSE	11.5984
Denominator DF	15

Tests of Model Effects

Effect	Num DF	F Value	Pr > F
Model	11	976.43	<.0001
Intercept	1	4115.43	<.0001
swd	1	0.90	0.3587
nevermarried	1	0.11	0.7484
female	1	72.37	<.0001
othhis	1	1.60	0.2254
white	1	14.58	0.0017
black	1	19.17	0.0005
other	1	10.70	0.0052
AGEC	1	68.98	<.0001
AGECSQ	1	186.29	<.0001
BMXBMI	1	31.47	<.0001
INDFMPIR	1	0.13	0.7194

NOTE: The denominator degrees of freedom for the F tests is 15.

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	67.7906698	1.05672549	64.15	<.0001
swd	0.6423621	0.67839152	0.95	0.3587
nevermarried	-0.1962480	0.60078311	-0.33	0.7484
female	-2.5724634	0.30239718	-8.51	<.0001
othhis	1.3100594	1.03604279	1.26	0.2254
white	2.0381251	0.53375932	3.82	0.0017
black	3.0300148	0.69201818	4.38	0.0005

---------- Imputation Number=3 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
other	3.0946465	0.94612558	3.27	0.0052
AGEC	0.1147436	0.01381518	8.31	<.0001
AGECSQ	-0.0104638	0.00076665	-13.65	<.0001
BMXBMI	0.1764109	0.03144619	5.61	<.0001
INDFMPIR	0.0399771	0.10918071	0.37	0.7194

NOTE: The denominator degrees of freedom for the t tests is 15.

Covariance of Estimated Regression Coefficients

	Intercept	swd	nevermarried	female	othhis	white
Intercept	1.1166687521	0.0872938503	0.1992490384	0.0073052017	0.0713237318	0.0413917988
swd	0.0872938503	0.4602150573	0.1154221739	0.0565653996	0.1756210326	-0.189375345
nevermarried	0.1992490384	0.1154221739	0.360940341	0.0178394053	-0.121378369	-0.06199349
female	0.0073052017	0.0565653996	0.0178394053	0.091444052	0.0830821404	-0.041222698
othhis	0.0713237318	0.1756210326	-0.121378369	0.0830821404	1.073384663	0.1207857993
white	0.0413917988	-0.189375345	-0.06199349	-0.041222698	0.1207857993	0.2848990153
black	0.2648965908	-0.072596202	-0.105519515	-0.08954031	0.3350553056	0.1879679049
other	0.1579430978	-0.116763786	-0.100903705	-0.130643688	0.1172657953	0.0191651771
AGEC	-0.002993028	-0.001203058	0.0043389765	-0.001119036	-0.003297104	-0.00039379
AGECSQ	-0.00054253	-0.000156454	-0.00029306	2.2630519E-6	0.0001245791	-0.00003072
BMXBMI	-0.031082734	-0.00245841	-0.004598202	-0.000353829	-0.006800163	-0.003021238
INDFMPIR	-0.062581849	-0.02009029	-0.019452332	-0.004269769	0.0074825274	-0.013553417

Covariance of Estimated Regression Coefficients

	black	other	AGEC	AGECSQ	BMXBMI	INDFMPIR
Intercept	0.2648965908	0.1579430978	-0.002993028	-0.00054253	-0.031082734	-0.062581849
swd	-0.072596202	-0.116763786	-0.001203058	-0.000156454	-0.00245841	-0.02009029
nevermarried	-0.105519515	-0.100903705	0.0043389765	-0.00029306	-0.004598202	-0.019452332
female	-0.08954031	-0.130643688	-0.001119036	2.2630519E-6	-0.000353829	-0.004269769
othhis	0.3350553056	0.1172657953	-0.003297104	0.0001245791	-0.006800163	0.0074825274
white	0.1879679049	0.0191651771	-0.00039379	-0.00003072	-0.003021238	-0.013553417
black	0.4788891553	0.309061574	-0.000324465	-0.000127877	-0.008524623	-0.014937859
other	0.309061574	0.8951536225	0.0019089904	0.0001316925	-0.006199556	0.0178344594
AGEC	-0.000324465	0.0019089904	0.0001908591	-3.157894E-6	0.0001291712	0.0000511817
AGECSQ	-0.000127877	0.0001316925	-3.157894E-6	5.8775531E-7	0.0000133517	0.0000585408
BMXBMI	-0.008524623	-0.006199556	0.0001291712	0.0000133517	0.000988863	0.0012327736
INDFMPIR	-0.014937859	0.0178344594	0.0000511817	0.0000585408	0.0012327736	0.0119204283

---------- Imputation Number=4 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Data Summary

Number of Observations	5334
Sum of Weights	217700471
Weighted Mean of BPXDI1_1	70.49162
Weighted Sum of BPXDI1_1	1.53461E10

Design Summary

Number of Strata	15
Number of Clusters	30

Fit Statistics

R-square	0.1276
Root MSE	11.5693
Denominator DF	15

Tests of Model Effects

Effect	Num DF	F Value	Pr > F
Model	11	284.10	<.0001
Intercept	1	4102.44	<.0001
swd	1	0.72	0.4086
nevermarried	1	3.23	0.0924
female	1	61.82	<.0001
othhis	1	0.47	0.5047
white	1	13.82	0.0021
black	1	26.49	0.0001
other	1	10.48	0.0055
AGEC	1	43.76	<.0001
AGECSQ	1	168.97	<.0001
BMXBMI	1	42.91	<.0001
INDFMPIR	1	0.70	0.4167

NOTE: The denominator degrees of freedom for the F tests is 15.

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	67.6842323	1.05673541	64.05	<.0001
swd	0.4934705	0.58042187	0.85	0.4086
nevermarried	-1.0522205	0.58529764	-1.80	0.0924
female	-3.0160590	0.38359881	-7.86	<.0001
othhis	0.8006669	1.17133654	0.68	0.5047
white	2.3295533	0.62671164	3.72	0.0021
black	3.5882640	0.69712302	5.15	0.0001

---------- Imputation Number=4 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
other	2.2394156	0.69184341	3.24	0.0055
AGEC	0.0996907	0.01507043	6.61	<.0001
AGECSQ	-0.0102807	0.00079089	-13.00	<.0001
BMXBMI	0.2008542	0.03066138	6.55	<.0001
INDFMPIR	-0.1039985	0.12450567	-0.84	0.4167

NOTE: The denominator degrees of freedom for the t tests is 15.

Covariance of Estimated Regression Coefficients

	Intercept	swd	nevermarried	female	othhis	white
Intercept	1.1166897364	0.2032356341	0.0905773521	-0.034905947	-0.105202145	-0.083526945
swd	0.2032356341	0.3368895416	0.0625695391	0.0374217685	0.1372302232	-0.109553537
nevermarried	0.0905773521	0.0625695391	0.3425733315	0.0192378471	-0.263363032	0.0282771988
female	-0.034905947	0.0374217685	0.0192378471	0.1471480505	0.2260175972	0.0317363847
othhis	-0.105202145	0.1372302232	-0.263363032	0.2260175972	1.3720292891	0.203350159
white	-0.083526945	-0.109553537	0.0282771988	0.0317363847	0.203350159	0.3927674759
black	0.1921865944	-0.022314592	-0.001406195	-0.019114742	0.2739571345	0.3426354971
other	0.0873037058	-0.034615104	-0.008855324	-0.048131623	-0.015281475	0.0388487041
AGEC	-0.002859741	-0.001478477	0.0052314085	-0.000589538	-0.008637925	0.0006600408
AGECSQ	-0.000371285	-0.000144834	-0.000366213	-0.000037831	0.0001846354	-0.000147288
BMXBMI	-0.027657151	-0.006769816	-0.003319615	-0.000422869	-0.002394618	-0.002425773
INDFMPIR	-0.066644672	-0.017253302	-0.014767679	-0.016982716	-0.015930679	-0.011716319

Covariance of Estimated Regression Coefficients

	black	other	AGEC	AGECSQ	BMXBMI	INDFMPIR
Intercept	0.1921865944	0.0873037058	-0.002859741	-0.000371285	-0.027657151	-0.066644672
swd	-0.022314592	-0.034615104	-0.001478477	-0.000144834	-0.006769816	-0.017253302
nevermarried	-0.001406195	-0.008855324	0.0052314085	-0.000366213	-0.003319615	-0.014767679
female	-0.019114742	-0.048131623	-0.000589538	-0.000037831	-0.000422869	-0.016982716
othhis	0.2739571345	-0.015281475	-0.008637925	0.0001846354	-0.002394618	-0.015930679
white	0.3426354971	0.0388487041	0.0006600408	-0.000147288	-0.002425773	-0.011716319
black	0.4859805025	0.2043277014	-0.000141298	-0.000210605	-0.011117636	-0.014543551
other	0.2043277014	0.4786473104	0.0003541423	0.0000181255	-0.006378146	0.0170361641
AGEC	-0.000141298	0.0003541423	0.0002271179	-5.938032E-6	0.0000579275	0.0002085771
AGECSQ	-0.000210605	0.0000181255	-5.938032E-6	6.2551079E-7	0.0000130452	0.0000385165
BMXBMI	-0.011117636	-0.006378146	0.0000579275	0.0000130452	0.00094012	0.0010363175
INDFMPIR	-0.014543551	0.0170361641	0.0002085771	0.0000385165	0.0010363175	0.0155016625

---------- Imputation Number=5 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Data Summary

Number of Observations	5334
Sum of Weights	217700471
Weighted Mean of BPXDI1_1	70.38454
Weighted Sum of BPXDI1_1	1.53227E10

Design Summary

Number of Strata	15
Number of Clusters	30

Fit Statistics

R-square	0.1212
Root MSE	11.5820
Denominator DF	15

Tests of Model Effects

Effect	Num DF	F Value	Pr > F
Model	11	101.31	<.0001
Intercept	1	3435.67	<.0001
swd	1	1.55	0.2323
nevermarried	1	0.53	0.4799
female	1	68.96	<.0001
othhis	1	5.16	0.0383
white	1	18.57	0.0006
black	1	25.27	0.0002
other	1	8.97	0.0091
AGEC	1	111.77	<.0001
AGECSQ	1	154.50	<.0001
BMXBMI	1	45.35	<.0001
INDFMPIR	1	0.18	0.6762

NOTE: The denominator degrees of freedom for the F tests is 15.

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	66.9537664	1.14227056	58.61	<.0001
swd	0.7164651	0.57561108	1.24	0.2323
nevermarried	-0.3455396	0.47688840	-0.72	0.4799
female	-2.7013581	0.32529086	-8.30	<.0001
othhis	2.1537056	0.94839946	2.27	0.0383
white	2.2993557	0.53355142	4.31	0.0006
black	3.2621265	0.64894242	5.03	0.0002

---------- Imputation Number=5 ----------

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
other	2.4400075	0.81448217	3.00	0.0091
AGEC	0.1150968	0.01088681	10.57	<.0001
AGECSQ	-0.0101183	0.00081404	-12.43	<.0001
BMXBMI	0.2050520	0.03044855	6.73	<.0001
INDFMPIR	-0.0629634	0.14781060	-0.43	0.6762

NOTE: The denominator degrees of freedom for the t tests is 15.

Covariance of Estimated Regression Coefficients

	Intercept	swd	nevermarried	female	othhis	white
Intercept	1.3047820385	0.1739341717	0.1756225196	-0.079428376	0.1254684484	0.0063179746
swd	0.1739341717	0.331328121	0.0092462373	0.008052997	0.1913975215	-0.089849965
nevermarried	0.1756225196	0.0092462373	0.2274225503	0.0220908981	-0.124579618	-0.007482787
female	-0.079428376	0.008052997	0.0220908981	0.1058141454	0.0516485682	-0.0102675
othhis	0.1254684484	0.1913975215	-0.124579618	0.0516485682	0.8994615302	0.0851624312
white	0.0063179746	-0.089849965	-0.007482787	-0.0102675	0.0851624312	0.2846771168
black	0.2481475761	-0.028507784	-0.012662745	-0.067436939	0.2388953451	0.2094038848
other	0.1790938684	-0.001190964	-0.148784731	-0.158587959	0.1244252825	0.0140187363
AGEC	-0.000874157	-0.000837278	0.0022465132	-0.001023782	-0.002127906	0.0006635827
AGECSQ	-0.000579919	-0.000175929	-0.000255029	-0.000015391	0.0000634067	-0.000082571
BMXBMI	-0.030960389	-0.005018255	-0.005554388	0.0024004017	-0.006641859	-0.002441376
INDFMPIR	-0.110388144	-0.012216232	-0.00545267	-0.007602807	0.0182174379	-0.020766278

Covariance of Estimated Regression Coefficients

	black	other	AGEC	AGECSQ	BMXBMI	INDFMPIR
Intercept	0.2481475761	0.1790938684	-0.000874157	-0.000579919	-0.030960389	-0.110388144
swd	-0.028507784	-0.001190964	-0.000837278	-0.000175929	-0.005018255	-0.012216232
nevermarried	-0.012662745	-0.148784731	0.0022465132	-0.000255029	-0.005554388	-0.00545267
female	-0.067436939	-0.158587959	-0.001023782	-0.000015391	0.0024004017	-0.007602807
othhis	0.2388953451	0.1244252825	-0.002127906	0.0000634067	-0.006641859	0.0182174379
white	0.2094038848	0.0140187363	0.0006635827	-0.000082571	-0.002441376	-0.020766278
black	0.4211262624	0.2387350604	0.0006518013	-0.000082714	-0.009752461	-0.017265424
other	0.2387350604	0.6633812065	0.0009449441	0.000152913	-0.007442759	0.0160381061
AGEC	0.0006518013	0.0009449441	0.0001185227	-2.486626E-6	-1.723547E-6	0.0004235473
AGECSQ	-0.000082714	0.000152913	-2.486626E-6	6.626547E-7	0.0000137413	0.0000638389
BMXBMI	-0.009752461	-0.007442759	-1.723547E-6	0.0000137413	0.0009271142	0.0018432179
INDFMPIR	-0.017265424	0.0160381061	0.0004235473	0.0000638389	0.0018432179	0.0218479722

```
* print out outmean data set for clarity of use in MIANALYZE ;
proc print data=outestimates ;
title "Print Out of SurveyReg Output Data Set for Use with PROC MIANALYZE" ;
run ;
```

Print Out of SurveyReg Output Data Set for Use with PROC MIANALYZE

Obs	_Imputation_	Parameter	Estimate	StdErr	DenDF	tValue	Probt
1	1	Intercept	68.0406082	1.36176135	15	49.97	<.0001
2	1	swd	0.7474112	0.60863579	15	1.23	0.2384
3	1	nevermarried	-0.3441065	0.63270453	15	-0.54	0.5945
4	1	female	-3.1855697	0.32213176	15	-9.89	<.0001
5	1	othhis	1.0890209	0.94896405	15	1.15	0.2691
6	1	white	2.0939424	0.54163884	15	3.87	0.0015
7	1	black	2.4439351	0.71883323	15	3.40	0.0040
8	1	other	1.3240605	0.79264065	15	1.67	0.1156
9	1	AGEC	0.1046525	0.01482102	15	7.06	<.0001
10	1	AGECSQ	-0.0102798	0.00084970	15	-12.10	<.0001
11	1	BMXBMI	0.1899686	0.03795878	15	5.00	0.0002
12	1	INDFMPIR	-0.0268119	0.12253333	15	-0.22	0.8297
13	2	Intercept	66.7004451	1.31815017	15	50.60	<.0001
14	2	swd	0.5191823	0.68610313	15	0.76	0.4609
15	2	nevermarried	-1.3166156	0.64152958	15	-2.05	0.0580
16	2	female	-2.8478990	0.35991542	15	-7.91	<.0001
17	2	othhis	1.6317654	0.82400871	15	1.98	0.0663
18	2	white	2.2643456	0.59426166	15	3.81	0.0017
19	2	black	3.7213964	0.70238468	15	5.30	<.0001
20	2	other	1.6134672	0.89319087	15	1.81	0.0910
21	2	AGEC	0.1035105	0.01407620	15	7.35	<.0001
22	2	AGECSQ	-0.0096211	0.00090890	15	-10.59	<.0001
23	2	BMXBMI	0.2094385	0.03702365	15	5.66	<.0001
24	2	INDFMPIR	0.0507280	0.13793506	15	0.37	0.7182
25	3	Intercept	67.7906698	1.05672549	15	64.15	<.0001
26	3	swd	0.6423621	0.67839152	15	0.95	0.3587
27	3	nevermarried	-0.1962480	0.60078311	15	-0.33	0.7484
28	3	female	-2.5724634	0.30239718	15	-8.51	<.0001
29	3	othhis	1.3100594	1.03604279	15	1.26	0.2254
30	3	white	2.0381251	0.53375932	15	3.82	0.0017
31	3	black	3.0300148	0.69201818	15	4.38	0.0005
32	3	other	3.0946465	0.94612558	15	3.27	0.0052
33	3	AGEC	0.1147436	0.01381518	15	8.31	<.0001
34	3	AGECSQ	-0.0104638	0.00076665	15	-13.65	<.0001
35	3	BMXBMI	0.1764109	0.03144619	15	5.61	<.0001
36	3	INDFMPIR	0.0399771	0.10918071	15	0.37	0.7194
37	4	Intercept	67.6842323	1.05673541	15	64.05	<.0001
38	4	swd	0.4934705	0.58042187	15	0.85	0.4086
39	4	nevermarried	-1.0522205	0.58529764	15	-1.80	0.0924
40	4	female	-3.0160590	0.38359881	15	-7.86	<.0001
41	4	othhis	0.8006669	1.17133654	15	0.68	0.5047
42	4	white	2.3295533	0.62671164	15	3.72	0.0021
43	4	black	3.5882640	0.69712302	15	5.15	0.0001
44	4	other	2.2394156	0.69184341	15	3.24	0.0055
45	4	AGEC	0.0996907	0.01507043	15	6.61	<.0001
46	4	AGECSQ	-0.0102807	0.00079089	15	-13.00	<.0001
47	4	BMXBMI	0.2008542	0.03066138	15	6.55	<.0001
48	4	INDFMPIR	-0.1039985	0.12450567	15	-0.84	0.4167
49	5	Intercept	66.9537664	1.14227056	15	58.61	<.0001
50	5	swd	0.7164651	0.57561108	15	1.24	0.2323
51	5	nevermarried	-0.3455396	0.47688840	15	-0.72	0.4799
52	5	female	-2.7013581	0.32529086	15	-8.30	<.0001
53	5	othhis	2.1537056	0.94839946	15	2.27	0.0383
54	5	white	2.2993557	0.53355142	15	4.31	0.0006
55	5	black	3.2621265	0.64894242	15	5.03	0.0002
56	5	other	2.4400075	0.81448217	15	3.00	0.0091
57	5	AGEC	0.1150968	0.01088681	15	10.57	<.0001
58	5	AGECSQ	-0.0101183	0.00081404	15	-12.43	<.0001
59	5	BMXBMI	0.2050520	0.03044855	15	6.73	<.0001
60	5	INDFMPIR	-0.0629634	0.14781060	15	-0.43	0.6762

```
* use PROC MIANALYZE to analyze the combined data sets (fully imputed and taking complex sample design into account)
        note use of test statement for multi-parameter test ;

proc mianalyze parms=outestimates covb=regcovb ;
modeleffects intercept swd nevermarried female othhis white black other agec agecsq bmxbmi indfmpir ;
testmar_race: test swd =0, nevermarried=0, othhis=0, white=0, black=0, other=0 / mult ;
run ;
```

The MIANALYZE Procedure

Model Information

PARMS Data Set	WORK.OUTESTIMATES
COVB Data Set	WORK.REGCOVB
Number of Imputations	5

Variance Information

Parameter	Variance: Between	Variance: Within	Variance: Total	DF	Relative Increase in Variance	Fraction Missing Information	Relative Efficiency
intercept	0.331633	1.426011	1.823970	84.027	0.279072	0.236150	0.954900
swd	0.013035	0.393922	0.409564	2742.1	0.039710	0.038894	0.992281
nevermarried	0.249578	0.348562	0.648056	18.729	0.859225	0.511648	0.907170
female	0.059558	0.115543	0.187012	27.388	0.618555	0.422828	0.922028
othhis	0.271435	0.984880	1.310602	64.76	0.330723	0.270709	0.948639
white	0.017030	0.321773	0.342208	1121.6	0.063510	0.061390	0.987871
black	0.256643	0.479212	0.787184	26.133	0.642663	0.433025	0.920298
other	0.488551	0.692650	1.278912	19.035	0.846403	0.507564	0.907842
agec	0.000048796	0.000191	0.000249	72.574	0.306794	0.255020	0.951471
agecsq	0.000000103	0.000000685	0.000000809	170.36	0.180956	0.162997	0.968430
bmxbmi	0.000176	0.001134	0.001345	161.54	0.186745	0.167601	0.967567
indfmpir	0.004386	0.016662	0.021926	69.404	0.315911	0.261062	0.950379

Parameter Estimates

Parameter	Estimate	Std Error	95% Confidence Limits		DF	Minimum	Maximum
intercept	67.433944	1.350544	64.74825	70.11964	84.027	66.700445	68.040608
swd	0.623778	0.639972	-0.63110	1.87865	2742.1	0.493470	0.747411
nevermarried	-0.650946	0.805019	-2.33752	1.03563	18.729	-1.316616	-0.196248
female	-2.864670	0.432449	-3.75139	-1.97794	27.388	-3.185570	-2.572463
othhis	1.397044	1.144815	-0.88947	3.68356	64.76	0.800667	2.153706
white	2.205064	0.584986	1.05727	3.35285	1121.6	2.038125	2.329553
black	3.209147	0.887234	1.38586	5.03243	26.133	2.443935	3.721396
other	2.142319	1.130890	-0.22436	4.50900	19.035	1.324060	3.094646
agec	0.107539	0.015793	0.07606	0.13902	72.574	0.099691	0.115097
agecsq	-0.010153	0.000899	-0.01193	-0.00838	170.36	-0.010464	-0.009621

Parameter Estimates

Parameter	Theta0	t for H0: Parameter=Theta0	Pr > |t|
intercept	0	49.93	<.0001
swd	0	0.97	0.3298
nevermarried	0	-0.81	0.4289
female	0	-6.62	<.0001
othhis	0	1.22	0.2268
white	0	3.77	0.0002
black	0	3.62	0.0013
other	0	1.89	0.0735
agec	0	6.81	<.0001
agecsq	0	-11.29	<.0001

The MIANALYZE Procedure

Parameter Estimates

Parameter	Estimate	Std Error	95% Confidence Limits		DF	Minimum	Maximum
bmxbmi	0.196345	0.036677	0.12392	0.26877	161.54	0.176411	0.209439
indfmpir	-0.020614	0.148074	-0.31598	0.27475	69.404	-0.103998	0.050728

Parameter Estimates

Parameter	Theta0	t for H0: Parameter=Theta0	Pr > |t|
bmxbmi	0	5.35	<.0001
indfmpir	0	-0.14	0.8897

The MIANALYZE Procedure
Test: testmar_race

Test Specification

Parameter	L Matrix: intercept	swd	nevermarried	female	othhis	white	black	other
TestPrm1	0	1.000000	0	0	0	0	0	0
TestPrm2	0	0	1.000000	0	0	0	0	0
TestPrm3	0	0	0	0	1.000000	0	0	0
TestPrm4	0	0	0	0	0	1.000000	0	0
TestPrm5	0	0	0	0	0	0	1.000000	0
TestPrm6	0	0	0	0	0	0	0	1.000000

Test Specification

Parameter	L Matrix: agec	agecsq	bmxbmi	indfmpir	C
TestPrm1	0	0	0	0	0
TestPrm2	0	0	0	0	0
TestPrm3	0	0	0	0	0
TestPrm4	0	0	0	0	0
TestPrm5	0	0	0	0	0
TestPrm6	0	0	0	0	0

Variance Information

Parameter	Variance: Between	Within	Total	DF	Relative Increase in Variance	Fraction Missing Information	Relative Efficiency
TestPrm1	0.013035	0.393922	0.409564	2742.1	0.039710	0.038894	0.992281
TestPrm2	0.249578	0.348562	0.648056	18.729	0.859225	0.511648	0.907170
TestPrm3	0.271435	0.984880	1.310602	64.76	0.330723	0.270709	0.948639
TestPrm4	0.017030	0.321773	0.342208	1121.6	0.063510	0.061390	0.987871
TestPrm5	0.256643	0.479212	0.787184	26.133	0.642663	0.433025	0.920298
TestPrm6	0.488551	0.692650	1.278912	19.035	0.846403	0.507564	0.907842

Parameter Estimates

Parameter	Estimate	Std Error	95% Confidence Limits		DF	Minimum	Maximum
TestPrm1	0.623778	0.639972	-0.63110	1.878654	2742.1	0.493470	0.747411
TestPrm2	-0.650946	0.805019	-2.33752	1.035631	18.729	-1.316616	-0.196248
TestPrm3	1.397044	1.144815	-0.88947	3.683558	64.76	0.800667	2.153706
TestPrm4	2.205064	0.584986	1.05727	3.352854	1121.6	2.038125	2.329553

Parameter Estimates

Parameter	C	t for H0: Parameter=C	Pr > |t|
TestPrm1	0	0.97	0.3298
TestPrm2	0	-0.81	0.4289
TestPrm3	0	1.22	0.2268
TestPrm4	0	3.77	0.0002

The MIANALYZE Procedure
Test: testmar_race

Parameter Estimates

Parameter	Estimate	Std Error	95% Confidence Limits		DF	Minimum	Maximum
TestPrm5	3.209147	0.887234	1.38586	5.032431	26.133	2.443935	3.721396
TestPrm6	2.142319	1.130890	-0.22436	4.509002	19.035	1.324060	3.094646

Parameter Estimates

Parameter	C	t for H0: Parameter=C	Pr > |t|
TestPrm5	0	3.62	0.0013
TestPrm6	0	1.89	0.0735

Multivariate Inference
Assuming Proportionality of Between/Within Covariance Matrices

Avg Relative Increase in Variance	Num DF	Den DF	F for H0: Parameter=Theta0	Pr > F
0.660682	6	118	3.50	0.0032

```
*create indicators for complete case regression analysis for comparison to imputed regression analysis ;
data c11_cc ;
set c11 ;
* create indicator variables for regression ;
* note different coding approach for missing data on marcat ;
married=. ; swd=. ;  nevermarried= . ;
if marcat=1 then married=1 ; else if marcat in (2,3) then married=0 ;
if marcat=2 then swd=1 ; else if marcat in (1,3) then swd=0 ;
if marcat=3 then nevermarried=1 ; else if marcat in (1,2) then nevermarried=0 ;

male=0 ; female=0 ;
if riagendr=1 then male=1 ;
if riagendr=2 then female=1 ;

mex=0 ; othhis=0 ; white=0 ; black=0 ; other=0 ;
if ridreth1 =1 then mex=1 ;
else if ridreth1 =2 then othhis=1 ;
else if ridreth1=3 then white=1 ;
else if ridreth1=4 then black=1 ;
else if ridreth1=5 then other=1 ;

* comparison to complete case regression using SurveyReg but no imputation ;
proc surveyreg data=c11_cc ;
strata sdmvstra ;
cluster sdmvpsu ;
weight wtmec2yr ;
model bpxdi1_1 = swd nevermarried female othhis white black other agec agecsq bmxbmi indfmpir / solution ;
run ;
```

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Data Summary

Number of Observations	4308
Sum of Weights	181480256
Weighted Mean of BPXDI1_1	70.71545
Weighted Sum of BPXDI1_1	1.28335E10

Design Summary

Number of Strata	15
Number of Clusters	30

Fit Statistics

R-square	0.1491
Root MSE	11.3393
Denominator DF	15

Tests of Model Effects

Effect	Num DF	F Value	Pr > F
Model	11	354.87	<.0001
Intercept	1	2208.04	<.0001
swd	1	2.22	0.1571
nevermarried	1	0.42	0.5256
female	1	48.07	<.0001
othhis	1	2.02	0.1753
white	1	10.50	0.0055
black	1	14.48	0.0017
other	1	3.24	0.0920
AGEC	1	58.08	<.0001
AGECSQ	1	192.57	<.0001
BMXBMI	1	25.63	0.0001
INDFMPIR	1	0.61	0.4467

NOTE: The denominator degrees of freedom for the F tests is 15.

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	68.2871395	1.45323287	46.99	<.0001
swd	1.0339497	0.69424703	1.49	0.1571
nevermarried	-0.3729060	0.57385413	-0.65	0.5256
female	-2.6992622	0.38932859	-6.93	<.0001
othhis	1.6527524	1.16164036	1.42	0.1753
white	2.1453575	0.66203832	3.24	0.0055
black	3.3105810	0.86987652	3.81	0.0017
other	1.6638912	0.92440123	1.80	0.0920
AGEC	0.1193541	0.01566089	7.62	<.0001
AGECSQ	-0.0123063	0.00088682	-13.88	<.0001
BMXBMI	0.1973282	0.03897582	5.06	0.0001

The SURVEYREG Procedure

Regression Analysis for Dependent Variable BPXDI1_1

Estimated Regression Coefficients

Parameter	Estimate	Standard Error	t Value	Pr > |t|
INDFMPIR	-0.1076662	0.13778384	-0.78	0.4467

NOTE: The denominator degrees of freedom for the t tests is 15.