Proc Surveyfreq: Why Do a Three Way Table in SAS When We Want Two Way Table Information?

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ABSTRACT:

A Proc Surveyfreq procedure in SAS® has an advantage over Proc Freq in that it incorporates multi-stage probability sampling design into the analyses. Several nationally representative data have multi-stage probability sampling design. Most of the time we need two way table information for the group of our interest, e.g.: patients with a certain disease. There are two ways to get group specific results in Proc Surveyfreq: (i) use "by statement" (ii) do "three way tabulation." "By statement" will provide group specific results but it will not give valid domain analysis and it will not preserve the sampling design. Hence, the results will not be generalizable to the population level. "Three way tables" will provide group specific results with valid domain analysis while preserving the sampling design. In the current paper, using Medical Expenditure Panel Survey (MEPS) data, we show that three way tables should be requested when we need two way table information primarily for valid domain analysis and extrapolating results at population level. This paper can serve as a guide to researchers who deal with single stage or multi-stage probability survey data which uses clustering, stratification and weighting.

Key words: Proc surveyfreq, Three way tables, By statement

INTRODUCTION:

Use of complex multi-stage probability survey design is highly prevalent in US for data collection. As a result, several nationally representative datasets do not employ a simple random sample design but instead incorporate multi-stage probability survey design elements, such as stratification, clustering and weighting. Conventional SAS procedures such as Proc Freq are not appropriate to analyze data with complex multi-stage sampling design.[1] SAS survey procedure gives power and flexibility to analyze data from complex samples because it incorporates complex sampling design into analysis.[2]

Five Survey procedures are available for data analysis - Proc Surveymeans, Proc Surveyfreq, Proc Surveylogistic, Proc Surveyreg, Proc Surveyphreg. Out of these 5 procedures, Proc Surveyfreq is the only one which does not have domain statement in its syntax. However domain specific analysis can be obtained using Proc Surveyfreq by incorporating domain category in the table statement. The following how – to – do example shows how to get domain specific results using Proc Surveyfreq.

PROC SURVEYFREQ SYNTAX:

```
PROC SURVEYFREQ <options> ;
        BY variables ;
        CLUSTER variables ;
        REPWEIGHTS variables </ options> ;
        STRATA variables </ option> ;
        TABLES requests </ options> ;
        WEIGHT variable ;
```

HOW – TO – DO EXAMPLE:

Overview:

The objective is to find percentages of males and females having diabetes among obese patients.

To get results for the abovementioned objective, we have to cross-tabulate diabetes and sex among obese patients. The population of interest (cohort) is obese people.

The Medical Expenditure Panel Survey (MEPS) – 2008 full year consolidated data file was used for the analysis. The file can be downloaded free of charge from the following website - http://www.meps.ahrq.gov/mepsweb/data_stats/download_data_files.jsp. The MEPS is not a simple random sample; it utilizes complex multistage probability design employing clustering, stratification and weighting which enables researchers to extrapolate results at the national level.

Data preparation:

- ***SAS commands:***

```
Data meps08;
Set PUFLIB.h121;
keep dupersid AGE08X sex BMINDX53 VARSTR VARPSU PERWT08F DIABDX;
run;

*Recoding of variables;

Data meps08_1;
Set meps08;

If BMINDX53>=30 then domain = 1;     *Population of interest -
                                     only obese   patients -
                                     COHORT;
Else Domain = 0;

If DIABDX = 1 then diabetes = 1;     *Dependent variable;
Else Diabetes = 0;
```

```
                                                   *Independent variable;
If Sex = 1 then Male = 1;                                *Male= 1: Male;
Else Male = 0;                                           *Male= 0: Female;

run;
```

Analyses:

Since MEPS is a multi-stage probability sampling design, SAS survey procedure was used. In Proc Surveyfreq, two types of analyses can be performed to get cross-tabulation of diabetes by sex for the population of interest, i.e. obese patients.

- First, “By statement” was used to cross tabulate Diabetes * Sex. By statement separately requests results for obese and non-obese patients.
- Second, “Three way tabulation” was used where population of interest was added as a variable in the table statement. This also gives separate results for obese and non-obese patients.

1. By statement:

- ***SAS commands:***

```
/*Getting 2x2 table with BY statement in Proc Surveyfreq*/

Proc sort data = meps08_1; by domain; run;

Title "By statement";
Proc Surveyfreq data = meps08_1;

by domain;

Strata VARSTR;
Cluster VARPSU;
Weight PERWT08F;
Table Diabetes*Male / or;
Run;
```

SAS LOG:

```
NOTE: The BY statement provides completely separate analyses of the BY groups.  It
      does not provide a statistically valid subpopulation or domain analysis, where
      the total number of units in the subpopulation is not known with certainty. If
      you want a domain analysis, you should include the domain variables in your
      TABLES request.
```

Output:

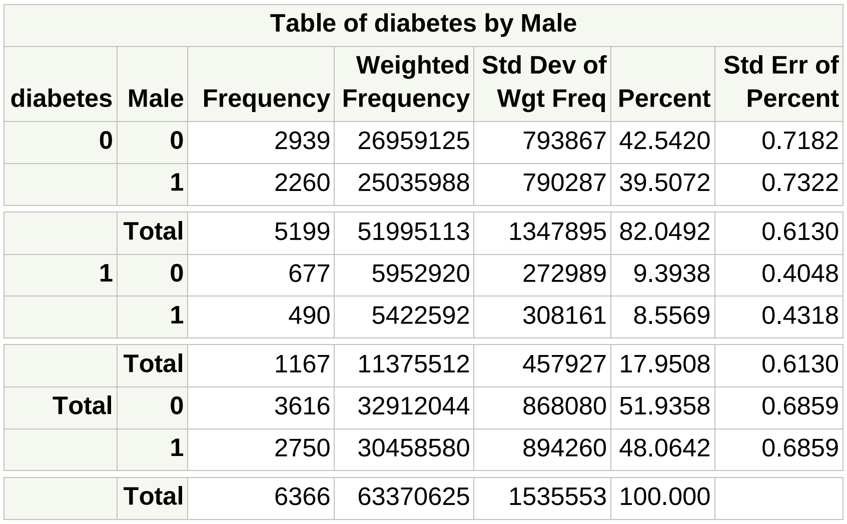
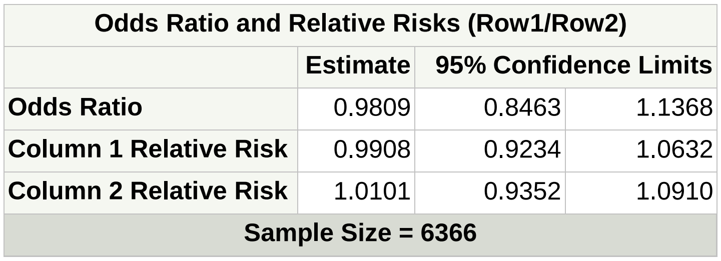


Table of diabetes by Male

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
0	0	2939	26959125	793867	42.5420	0.7182
	1	2260	25035988	790287	39.5072	0.7322
	Total	5199	51995113	1347895	82.0492	0.6130
1	0	677	5952920	272989	9.3938	0.4048
	1	490	5422592	308161	8.5569	0.4318
	Total	1167	11375512	457927	17.9508	0.6130
Total	0	3616	32912044	868080	51.9358	0.6859
	1	2750	30458580	894260	48.0642	0.6859
	Total	6366	63370625	1535553	100.000	



Odds Ratio and Relative Risks (Row1/Row2)

	Estimate	95% Confidence Limits	
Odds Ratio	0.9809	0.8463	1.1368
Column 1 Relative Risk	0.9908	0.9234	1.0632
Column 2 Relative Risk	1.0101	0.9352	1.0910

Sample Size = 6366

2. Three way tabulation:

SAS commands

```
/*Getting 2x2 table with Three way tabulation*/

Title "Domain statement";
Proc Surveyfreq data = meps08_1;
Strata VARSTR;
Cluster VARPSU;
Weight PERWT08F;

Table domain*Diabetes*Male / or;

Run;
```

- ***Output:***

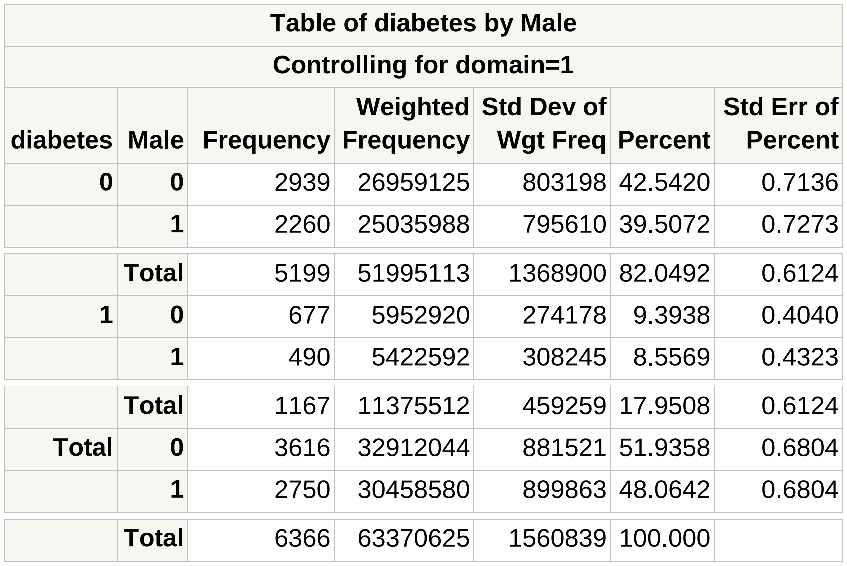
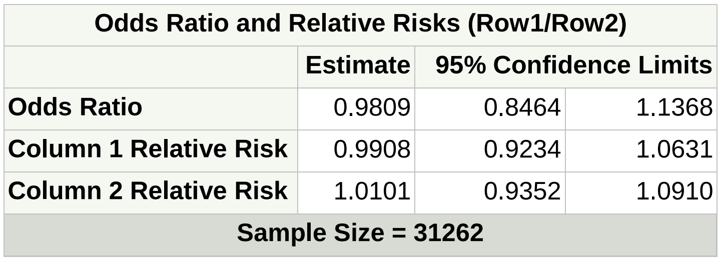


Table of diabetes by Male						
Controlling for domain=1						
diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
0	0	2939	26959125	803198	42.5420	0.7136
	1	2260	25035988	795610	39.5072	0.7273
	Total	5199	51995113	1368900	82.0492	0.6124
1	0	677	5952920	274178	9.3938	0.4040
	1	490	5422592	308245	8.5569	0.4323
	Total	1167	11375512	459259	17.9508	0.6124
Total	0	3616	32912044	881521	51.9358	0.6804
	1	2750	30458580	899863	48.0642	0.6804
	Total	6366	63370625	1560839	100.000	



Odds Ratio and Relative Risks (Row1/Row2)			
	Estimate	95% Confidence Limits	
Odds Ratio	0.9809	0.8464	1.1368
Column 1 Relative Risk	0.9908	0.9234	1.0631
Column 2 Relative Risk	1.0101	0.9352	1.0910
Sample Size = 31262			

DISCUSSION:

Comparison of above two outputs tells us several important things. The point estimates, in this case the percentage, obtained from both methods are identical. However, closer look at standard errors of percentage from both outputs reveal that standard errors are overestimated when two way tables were requested using by statement. Furthermore, it is clearly mentioned in the SAS log that by statement produces completely separate analysis of the BY groups. This is equivalent to sub-setting population of interest, obese patients, and performing Proc Surveyfreq on this sub-setted cohort. You will get exactly the same output as produced by “By statement”. Therefore, use of by statement in Proc Surveyfreq does not provide valid domain analysis.

The second method in which domain category was included in the table statement produced valid estimate of the standard error because it included all observations while calculating standard errors. Appendix shows the full SAS output; it produces results for both domain and includes all observations. Since our population of interest is obese patients (domain =1), we will look at that output only.

We also requested odds ratio (OR) estimate using OR option in table statement. Again, both methods produced identical point estimates but not the 95% confidence intervals (CI). Since by statement overestimated standard errors, it is expected that OR will have wider 95% CI. Three way tabulation produces valid domain analysis, thus giving us valid estimate of standard error and narrower confidence interval.

Despite the fact that both methods give identical point estimates, standard errors estimated using by statement are usually higher. While dealing with complex multi-stage probability survey design, the researcher should request three way tables by including domain category as the third variable in the table statement. It gives correct point estimates, as well as standard errors.

CONCLUSION:

Unlike other Proc survey procedures, Proc Surveyfreq does not have “domain” statement in its syntax. In order to perform proper domain analysis, domain category must be added in the table statement. In Proc Surveyfreq, three way tables should be requested when the researcher needs two way table information.

REFERENCES:

1. Mehta, H.B., Johnson, M.L. Advice to Advice to Health Services Researchers: Be Cautious Using the “Where” Statement in SAS® Programs for Nationally Representative Complex Survey Data. SCSUG 2011.
2. Sample Survey Design and Analysis. Available at: http://support.sas.com/rnd/app/da/new/dasurvey.html

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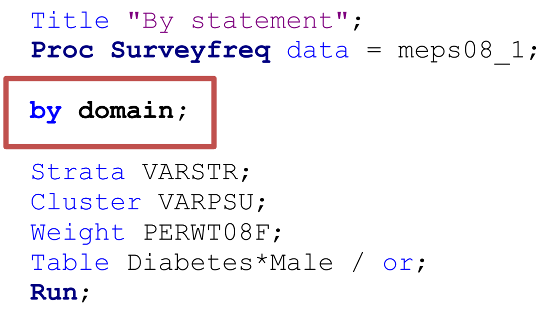
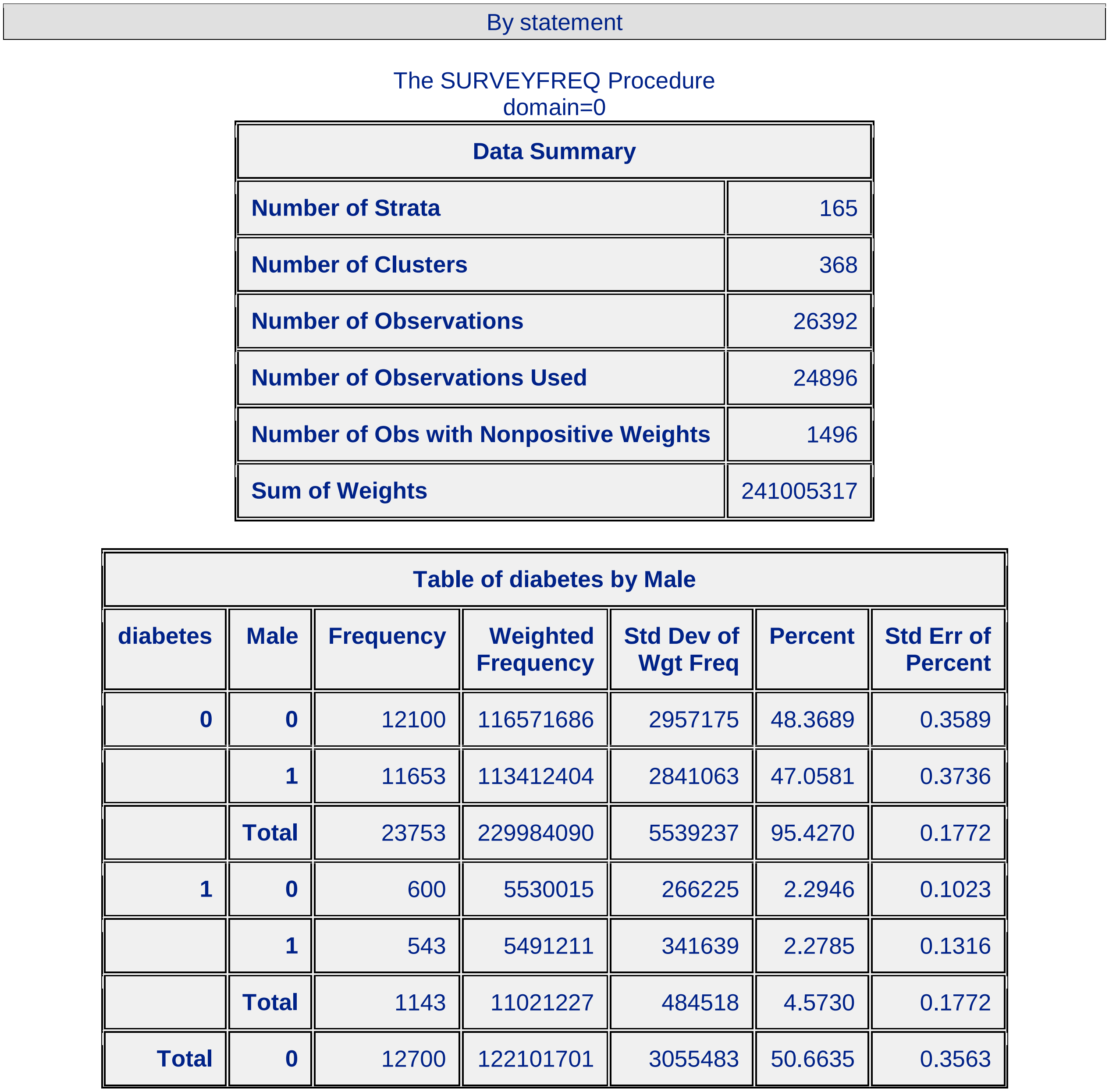
APPENDIX (Complete SAS output):



```
Title "By statement";
Proc Surveyfreq data = meps08_1;

by domain;

Strata VARSTR;
Cluster VARPSU;
Weight PERWT08F;
Table Diabetes*Male / or;
Run;
```



By statement

The SURVEYFREQ Procedure
domain=0

Data Summary	
Number of Strata	165
Number of Clusters	368
Number of Observations	26392
Number of Observations Used	24896
Number of Obs with Nonpositive Weights	1496
Sum of Weights	241005317

Table of diabetes by Male

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
0	0	12100	116571686	2957175	48.3689	0.3589
	1	11653	113412404	2841063	47.0581	0.3736
	Total	23753	229984090	5539237	95.4270	0.1772
1	0	600	5530015	266225	2.2946	0.1023
	1	543	5491211	341639	2.2785	0.1316
	Total	1143	11021227	484518	4.5730	0.1772
Total	0	12700	122101701	3055483	50.6635	0.3563

Table of diabetes by Male

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
	1	12196	118903616	2949151	49.3365	0.3563
	Total	24896	241005317	5753839	100.000	

Odds Ratio and Relative Risks (Row1/Row2)

	Estimate	95% Confidence Limits	
Odds Ratio	**1.0206**	0.8871	1.1743
Column 1 Relative Risk	**1.0102**	0.9420	1.0832
Column 2 Relative Risk	**0.9897**	0.9224	1.0620
Sample Size = 24896			

By statement

The SURVEYFREQ Procedure
domain=1

Data Summary

Number of Strata	165
Number of Clusters	363
Number of Observations	6674
Number of Observations Used	6366
Number of Obs with Nonpositive Weights	308
Sum of Weights	63370624.8

Table of diabetes by Male

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
0	**0**	2939	26959125	793867	42.5420	0.7182
	1	2260	25035988	790287	39.5072	0.7322

Table of diabetes by Male

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
	Total	5199	51995113	1347895	82.0492	0.6130
1	0	677	5952920	272989	9.3938	0.4048
	1	490	5422592	308161	8.5569	0.4318
	Total	1167	11375512	457927	17.9508	0.6130
Total	0	3616	32912044	868080	51.9358	0.6859
	1	2750	30458580	894260	48.0642	0.6859
	Total	6366	63370625	1535553	100.000	

Odds Ratio and Relative Risks (Row1/Row2)

	Estimate	95% Confidence Limits	
Odds Ratio	**0.9809**	0.8463	1.1368
Column 1 Relative Risk	**0.9908**	0.9234	1.0632
Column 2 Relative Risk	**1.0101**	0.9352	1.0910

Sample Size = 6366

```
Title "Domain statement";
Proc Surveyfreq data = meps08_1;
Strata VARSTR;
Cluster VARPSU;
Weight PERWT08F;

Table domain*Diabetes*Male / or;

Run;
```

Domain statement

The SURVEYFREQ Procedure

Data Summary	
Number of Strata	165
Number of Clusters	370
Number of Observations	33066
Number of Observations Used	31262
Number of Obs with Nonpositive Weights	1804
Sum of Weights	304375942

Table of diabetes by Male

Controlling for domain=0

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
0	0	12100	116571686	2984701	48.3689	0.3587
	1	11653	113412404	2870683	47.0581	0.3733
	Total	23753	229984090	5599434	95.4270	0.1772
1	0	600	5530015	266839	2.2946	0.1023
	1	543	5491211	342369	2.2785	0.1316
	Total	1143	11021227	486395	4.5730	0.1772
Total	0	12700	122101701	3084712	50.6635	0.3561
	1	12196	118903616	2981163	49.3365	0.3561

Table of diabetes by Male

Controlling for domain=0

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
	Total	24896	241005317	5817991	100.000	

Odds Ratio and Relative Risks (Row1/Row2)

	Estimate	95% Confidence Limits	
Odds Ratio	**1.0206**	0.8872	1.1742
Column 1 Relative Risk	**1.0102**	0.9421	1.0832
Column 2 Relative Risk	**0.9897**	0.9225	1.0619

Sample Size = 31262

Table of diabetes by Male

Controlling for domain=1

diabetes	Male	Frequency	Weighted Frequency	Std Dev of Wgt Freq	Percent	Std Err of Percent
0	**0**	2939	26959125	803198	42.5420	0.7136
	1	2260	25035988	795610	39.5072	0.7273
	Total	5199	51995113	1368900	82.0492	0.6124
1	**0**	677	5952920	274178	9.3938	0.4040
	1	490	5422592	308245	8.5569	0.4323
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Total	**0**	3616	32912044	881521	51.9358	0.6804
	1	2750	30458580	899863	48.0642	0.6804
	Total	6366	63370625	1560839	100.000	

Odds Ratio and Relative Risks (Row1/Row2)

	Estimate	95% Confidence Limits	

Odds Ratio and Relative Risks (Row1/Row2)			
	Estimate	**95% Confidence Limits**	
Odds Ratio	**0.9809**	0.8464	1.1368
Column 1 Relative Risk	**0.9908**	0.9234	1.0631
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