An Evaluation of Design Effects for Selected Estimates in the Medical Expenditure Panel Survey

David Kashihara, Marc Zodet, and Trena M. Ezzati-Rice
Agency for Healthcare Research and Quality
540 Gaither Road, Rockville, Maryland 20850

Abstract

The Medical Expenditure Panel Survey (MEPS) is a large, nationally representative panel survey of the U.S. civilian noninstitutionalized population. The annual survey collects information to produce national- and regional-level estimates of health care use, health status, health conditions, medical expenditures, sources of payment, insurance coverage, and health care access for the nation as well as for policy-relevant subgroups. The Household Component of the MEPS has a complex survey design that uses the National Health Interview Survey (NHIS) as the sampling frame. The NHIS has a stratified, multistage area probability design and the MEPS sample is selected from households that responded to the prior year's NHIS. Because of this complex sample design, variances will generally be higher than those that would have resulted from a simple random sample design. Ratios of these variances, called design effects, are used as a measure of precision to help assess the quality of the survey estimates. In this study, design effects for various MEPS survey estimates by selected population subgroups will be examined for 2001 through 2008.

Key Words: survey efficiency, subgroup over-sampling, sample redesign

1. Introduction

An annual sample survey can produce estimates on a wide variety of topics that are not necessarily limited to the primary focus of the study for which it serves. Besides the primary survey variables, data may also be collected on demographic and socio-economic items that support and enhance the survey estimates. Changes in the sample can occur from one year to the next for a variety of reasons, such as budgetary constraints, need for sample allocation adjustments, new over-sampling of policy-relevant subgroups, and survey redesign efforts. These changes can all have differing effects on the survey estimates. Calculating design effects for survey estimates can provide researchers with a unit-less measure that can be used to compare the precision of the estimates across survey years. Design effects are ratios of the actual survey variance to the variance that would have been obtained had the sample been selected using a simple random sample. Most large surveys do not use simple random sampling. Instead, due to cost efficiencies, data collection constraints and other reasons, samples are constructed using stratification, clustering, or a combination of these techniques. Because elements in a cluster are often homogeneous, cluster sampling is generally not as efficient as simple random sampling and therefore, more sample is necessary to achieve the same precision that would have been obtained by simple random sampling. The design effect in this case would be greater than one. With stratification, the sample selected is more efficient than one selected using simple random sampling because the use of strata ensures that sampled cases are drawn from different classifications in pre-determined numbers. Thus, due to

---

The views expressed in this paper are those of the authors and no official endorsement by the Department of Health and Human Services or the Agency for Healthcare Research and Quality is intended or should be inferred.

the more efficient nature of stratified sampling than for simple random sampling, the design effects for estimates will tend to be less than one. If simple random sampling was used to select the sample, the design effects should be close to one.

In this paper, design effects are calculated using data from the Household Component (HC) of the Medical Expenditure Panel Survey (MEPS) to achieve the following objectives: 1) to gauge the precision of key MEPS survey estimates regarding expenditures, utilization, and insurance status; 2) to evaluate the efficiency of various over-sampling strategies of selected race/ethnicity groups; 3) to examine the level of design effect variation by survey year and by policy-relevant subgroups; and 4) to assess the efficiency of the 2007 MEPS sample redesign. The MEPS-HC is a large, national probability sample survey sponsored by the Agency for Healthcare Research and Quality. The annual survey collects information from respondents to produce national- and regional-level estimates of health care use, health status, health conditions, medical expenditures, sources of payment, insurance coverage, and health care access for the U.S. civilian noninstitutionalized population as well as for policy-relevant subgroups. The MEPS-HC is a two year panel survey with a new panel of households introduced each year. Five rounds of interviews are conducted with each panel to yield health care data for two calendar years. The MEPS sample is a sub-sample of respondents to the prior year's National Health Interview Survey that is conducted by the National Center for Health Statistics (Cohen, 2000 and Ezzati-Rice et. al., 2008).

2. Data Files

Figure 1 displays the overlapping panel design for Panels 12 and 13 for the 2008 survey year. Panel 12 was in the field in 2007 and 2008 while Panel 13 was in the field in 2008 and 2009. Thus, both panels were in the field in 2008 – Panel 12 was in its second year of data collection, while Panel 13 was in its first year of data collection

For this study we looked at three types of data that can be produced from MEPS: Full Year data, Year 1 data, and Point-in-Time data. Each type of data set had its own advantages with respect to its content and the most recent data available for analysis. The Full Year data files contain data collected from both panels in a specific survey year. Figure 1 shows Survey Year 2008, where Panel 12 was in its second year of data collection (Rounds 3 - 5) and Panel 13 was in its first year of data collection (Rounds 1 - 3). The Full Year data were used for the comparison of survey estimate efficiency due to over-sampling. These files contain the most information of the three types of files. The Full Year file is the only file that contains medical expenditure estimates.

The Year 1 and the Point-in-Time data files were used for the comparison of survey estimate precision as a result of the sample redesign. The Year 1 data files, created specifically for this study, only use data from one panel – and only the first year of data collected for that panel (Rounds 1 - 3). Thus, in Figure 1, the 2007 Year 1 data file is created using data from Rounds 1 to 3 in Panel 12.

Similar to the Full Year data files, the Point-in-Time (PIT) files have data that are collected from both panels in a given survey year. However, the PIT files are used to provide an early snapshot of the data before the Full Year files are released. Thus, the PIT files are created from only the first rounds of data collection from each panel in the field for that given year. In Figure 1, the 2008 PIT file uses data from Round 3 of Panel 12 and Round 1 of Panel 13.

Figure 1 – MEPS overlapping panel design in 2008 (Panel 12 and Panel 13)

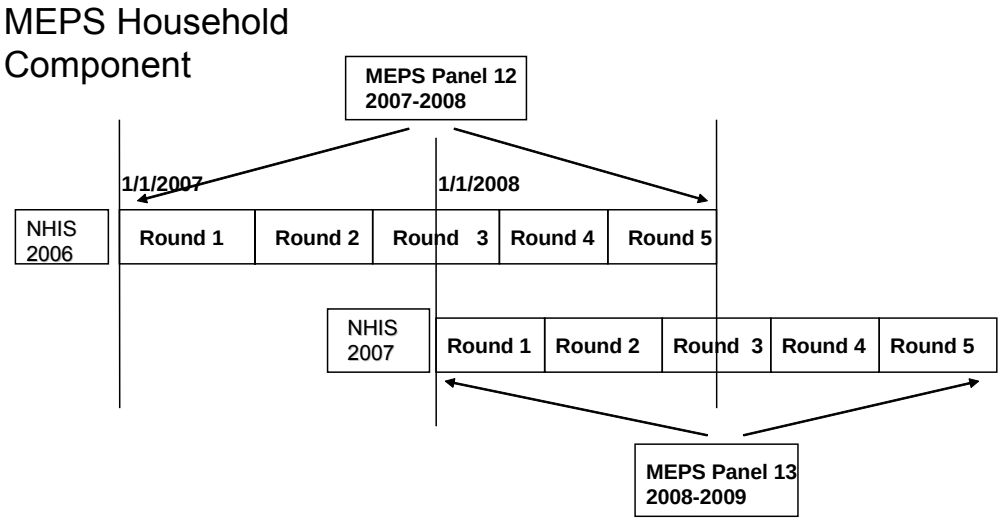


Table 1 summarizes the data years used by the different file types for this study. For the Full Year analyses, the 2001 data were used because that year there was no MEPS over-sampling of any subdomains. In 2003, Asians and Low Income households were over-sampled. In 2005 and 2006, Black households were also over-sampled.

Table 1 – Data Years for the Types of Data Files

	Data Years					
Data File Types	2001	2003	2005	2006	2007	2008
Full Year	√	√	√	√		
Year 1			√	√	√	
Point-in-Time			√	√	√	√

For the Year 1 analyses, 2005 and 2006 MEPS data were used because these were the most recent years before the sample redesign. 2007 was used because it was the first year that used the new sample design (Ezzati-Rice, et. al., 2008).

For the PIT analyses, 2005 and 2006 were the most recent years before the sample redesign. 2007 had one panel with the old design and one panel with the new design. 2008 was the first year based completely on the new sample design.

3. Methods

Design effects were used in this study because they allow for the comparison of sampling variances of survey statistics and the statistics of population subgroups. The MEPS is a complex survey design that includes both clustering and stratification, which affect design effects differently. Clustering is less efficient than simple random sampling and will generally produce design effects greater than one. Stratification is more efficient than simple random sampling and will usually produce design effects less than one. A design effect of one indicates that the sample was as efficient as that of a simple random sample.

$$Deff = (var_{cplx} / var_{srs})$$

The SUDAAN statistical software provides the option of calculating design effects four different ways. For this study, the design effect used was calculated using Deff1 (Shah, et. al., 1996). This particular design effect assumes the use of stratification, clustering, and unequal weighting in the data.

Design effects were examined for three key analytical topics: medical expenditures, health care utilization, and health insurance status. Health care utilization was defined as "percent with a visit" for the following estimates:

- office-based medical provider services
- hospital outpatient services
- emergency department (ED)
- hospital inpatient services
- dental services
- home health services
- prescription medicines (Rx)

For health insurance status, percent uninsured for people younger than 65 years was the variable of interest. For medical expenditures, total expenditures was the variable of interest. Total expenditures are the sum of the payments for out-of-pocket expenses as well as payments by private insurance, Medicaid, Medicare, and other sources during the year. Payments for over-the-counter drugs are not included in this amount ("MEPS 2006 Full Year Consolidated Data File", 2008).

The MEPS data files contain different information based on the data collection rounds involved and the release dates of the files. For example, medical expenditures can only be found in the Full Year files. Health care utilization can be found in the Full Year and the Year 1 files. Health insurance information can be found in all three types of files. The file contents are summarized in Table 2 for the three analytical variables in the studies.

Table 2 – Analytical Data Content of the Data Files

	Data File Type		
Survey Estimate	Full Year	Year 1	Point-in-Time
Expenditures	√		
Utilization	√	√	
Insurance	√	√	√

Each year the MEPS subsamples respondents to the prior year's National Health Interview Survey (NHIS). Thus, characteristics of the NHIS sample are reflected in the MEPS sample, such as their over-sampling of Blacks (since 1985), Hispanics (since 1995), and Asians (since 2006). The following is a summary of the over-sampling performed in recent years of MEPS surveys. The over-sampling rate is in parentheses.

2001 – none
2002 – Asians (1.00), low income (1.00)*
2003 – Asians (1.00), low income (1.00)
2004 – Asians (1.00), low income (1.00), Blacks (0.67)
2005 – Asians (1.00), low income (1.00), Blacks (0.75)
2006 – Asians (1.00), low income (1.00), Blacks (0.75)
2007 – Asians (1.00), low income (1.00), Blacks (0.90), Hispanics (0.90)
2008 – Asians (1.00), low income (1.00), Blacks (1.00), Hispanics (1.00)

* less than 200% of the CPS poverty line as predicted

For each analytical topic (total medical expenditures, health care utilization, and health insurance status), design effects were calculated for 36 subpopulations within each of the following key variables:

Age (5)	< 65, 0-17, 18-44, 45-64, 65+
Gender (2)	male, female
Race/ethnicity (5)	Hispanic, White only, Black only, Asian only, other
Employment status (2)	employed, unemployed
Health insurance (6)	any private, public only, uninsured, Medicare only, Medicare & private, Medicare and other public
Family income**(5)	negative or poor, near-poor, low income, middle income, high income
Region (4)	Northeast, Midwest, South, West
MSA status (2)	MSA, non-MSA
Health status (5)	excellent, very good, good, fair, poor

Total:subpulations = 36

** family income groups were constructed by calculating percentages from dividing family income by the CPS poverty line. The categories are negative or poor (less then 100%), near poor (100% to less than 125%), low income (125% to less than 200%), middle income (200% to less than 400%), and high income (greater than or equal to 400%).

4. Results

4.1. General Findings

Using the Full Year data files (the only files that contain medical expenditure data), median design effects for key estimates are shown in Table 3. For most of the estimates, the median design effects generally increased between 2001 and 2006. The notable exceptions were for the Any Private and the Public Only insurance estimates. The median design effect of the uninsured remained relatively stable across 2001, 2003, 2005 and 2006.

Table 3 – Median Design Effects for Key Estimates

	Data Years			
Survey Estimate	**2001**	**2003**	**2005**	**2006**
Total Expenditures	1.80	2.34	2.29	2.16
Utilization				
ED	1.69	1.73	1.75	1.77
Inpatient	1.52	1.53	1.60	1.54
Office-based	1.91	2.11	2.25	2.33
Outpatient	1.96	2.00	2.44	2.31
Rx	1.81	1.99	2.13	2.05
Insurance (<65)				
Any private	3.61	3.36	3.33	3.25
Public only	3.02	3.01	2.69	2.65
Uninsured	2.45	2.42	2.35	2.44

The median design effects for the health insurance categories were higher than for the expenditure and utilization categories. A possible reason for this might be that type of insurance tends to be homogeneous within households – which are the ultimate clusters in the MEPS sample design.

Figure 2 displays box plots of the distribution of the subpopulation design effects by year within the seven utilization measures for estimates of percent with a visit or an event. The dots in the boxes represent the median design effect across the 36 subpopulations. The median design effects generally range between 2 and 3 within all of the utilization measures. The variation of the design effects across the subpopulations is less for hospital inpatient visits, emergency department visits, and home health visits.

Figure 2 – Distribution of Design Effects for Estimates of Percent with a Visit or Event (Full Year Data)

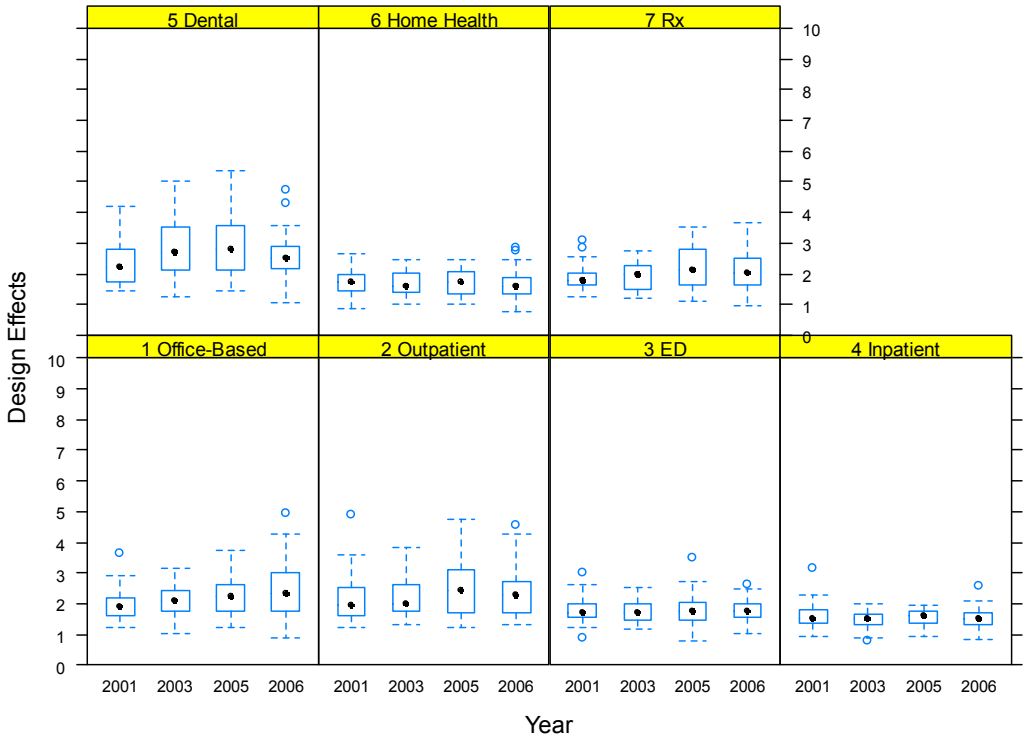


Figure 3 shows the distribution of design effects for total expenditures within the utilization measures over the 36 subpopulations. The median design effects generally range between 1.5 and 3. The variation of design effects for total healthcare expenditures across the subpopulations appears to be less for emergency department visits, hospital outpatient visits, and hospital inpatient visits. Interestingly, the outliers in the prescription medicine (Rx) plot were for the design effects of various geographic categories.

Figure 3 – Distributions of Design Effects for Estimates of Total Medical Expenditures (Full Year Data)

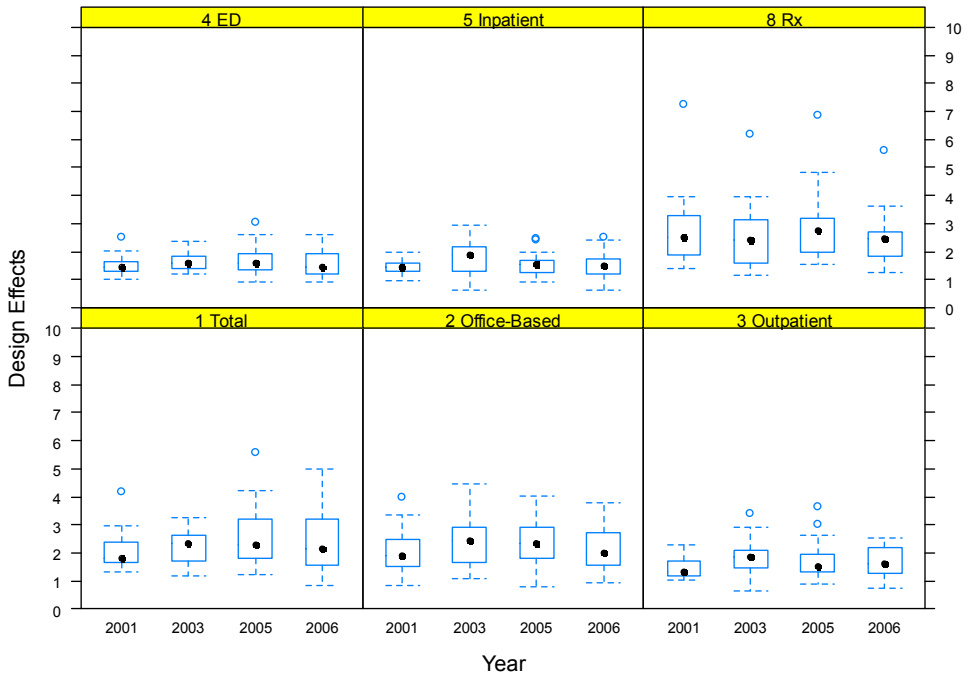


Figure 4 shows the distributions of design effects for the percent uninsured over the 36 subpopulations. The median design effects are all between 2 and 3 and the variation of the design effects is generally similar from year to year.

4.2. Over-sampling

As stated earlier in this paper, beginning in 2002 MEPS began over-sampling low income and selected race/ethnicity groups to increase the precision of those estimates. Asians and families with low income (a family income less than 200% of the CPS poverty line) were over-sampled each year from 2002 to 2007 and Blacks and Hispanics were over-sampled in 2007 and 2008.

Table 4 shows the design effects for estimates of total medical expenditures. The "Aggregate" row represents the combination of all 36 subpopulations for comparison with each of the race/ethnicity breakouts. For Asians, with no MEPS over-sample in 2001 the design effect was 2.77. The other years had over-samples of Asians and, as a result, the design effects in the subsequent years were lower. Interestingly though, the Hispanics, with no over-sample until 2007, followed a similar pattern. However, the design effects for Whites (no over-samples) increased steadily over the same period. There was an over-sample of Blacks for data years 2005 and 2006. The design effects for Blacks increased between 2001 and 2003 but decreased after that for the two over-sampled years.

Figure 4 – Distributions of Design Effects for Estimates of Percent Uninsured for Persons Less Than 65 Years of Age (Full Year Data)

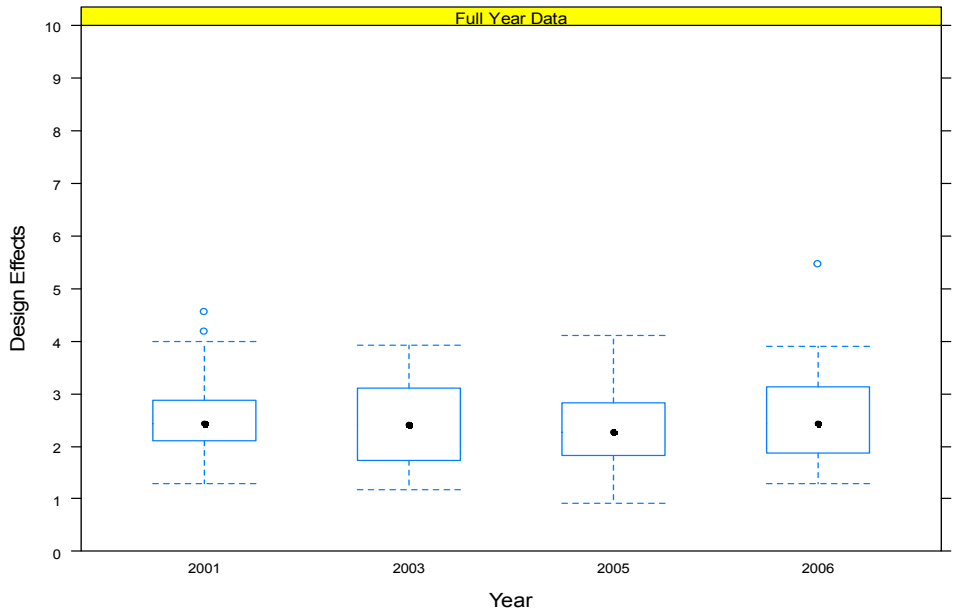


Table 4 – Impact of Over-Sampling according to Race/Ethnicity: Design Effects for Estimates of Total Medical Expenditures

	Sample Size (1,000's)				Design Effects			
Year	**2001**	**2003**	**2005**	**2006**	**2001**	**2003**	**2005**	**2006**
Aggregate	32.1	32.7	32.3	32.6	2.83	2.89	3.65	3.64
Hispanic	7.6	8.9	9.0	8.9	1.66	1.19	1.50	0.84
White only	18.6	16.6	15.9	16.0	2.86	3.06	3.61	4.21
Black only	4.7	5.1	5.3	5.6	1.43	1.74	1.57	1.44
Asian only	1.0	1.3	1.2	1.2	2.77	2.25	2.11	1.13

4.3. MEPS Sample Redesign

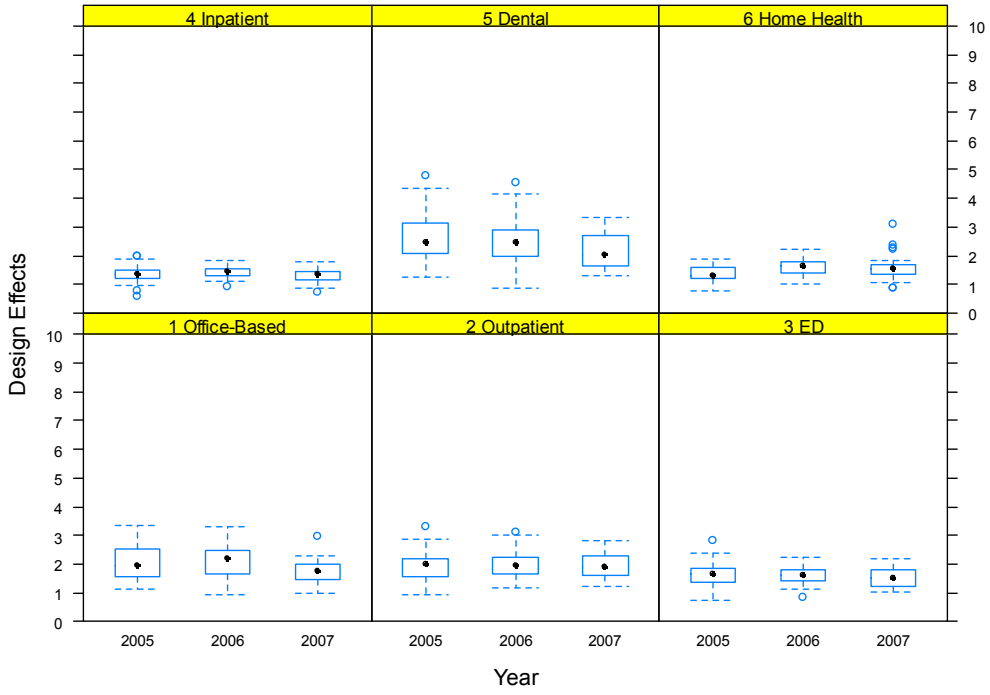
The MEPS was first conducted in 1996 and from that point until the 2007 sample the survey design was linked to the old NHIS sample design. However, in 2006, the NHIS was redesigned – which affected MEPS starting with data year 2007 since the MEPS sub-samples respondents to the prior year's NHIS. Thus, the 2007 MEPS Full Year and Point-in-Time data have one panel that is based on the old MEPS sample design and one panel that is based on the new MEPS sample design. As a result of the NHIS sample redesign, starting with MEPS Panel 12, there was now a new set of variance strata and primary sampling units (PSU's). Also, to insure acceptable precision levels with the race/ethnicity

estimates, over-samples were drawn from Blacks and Hispanics in addition to Asians and low income groups.

Since the new sample design began with Panel 12, Year 1 data of Panel 12 can be used to compare design effects for estimates before and after the sample redesign. Year 1 data include data from Rounds 1-3 of a panel since those data collection rounds occur in the first year that the panel is in the field.

Figure 5 shows box plots of the distribution of design effects for Year 1 (of 2005, 2006, and 2007) over the subpopulations within various utilization measures for estimates of percent with a visit or an event. Note: the 2007 data were collected based on the new MEPS sample design while the 2005 and 2006 data were collected based on the old sample design. The medians and the distributions of the design effects within each of the utilization measures did not appear to markedly change after the sample redesign.

Figure 5 – Distributions of Design Effects for Estimates of Percent with a Visit or Event (Year 1 Data)



For the estimates of the percent uninsured shown in Figure 6 (Year 1 only), the median design effects are all between 2 and 3, but the 2007 median, derived from data using the new MEPS sample design, is higher than the medians calculated using data from the old MEPS sample design (2005 and 2006).

Figure 6 – Distributions of Design Effects for Estimates of Percent Uninsured for Persons Less Than 65 Years of Age (Year 1 Data)

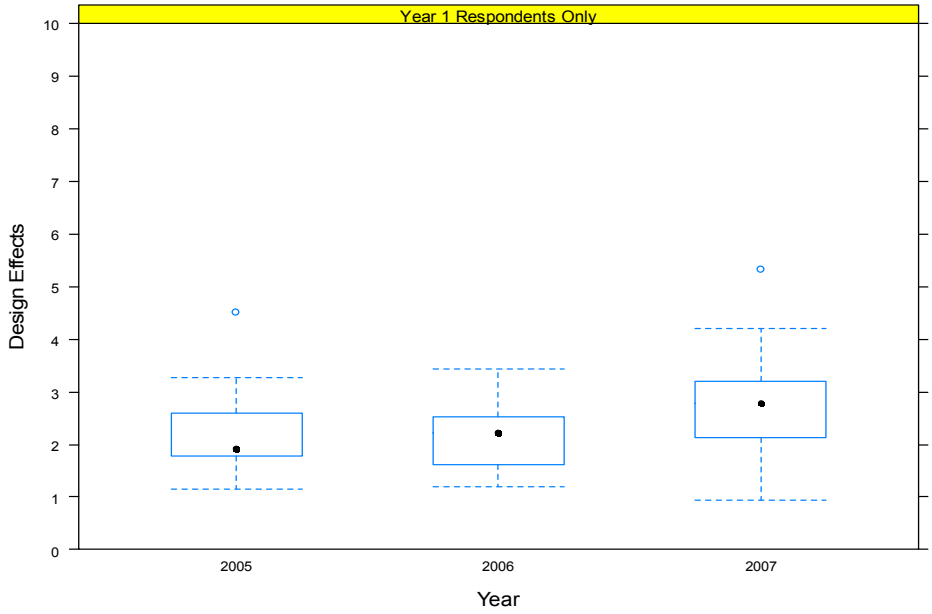


Table 5 shows the design effects of the estimates of the percent uninsured broken down by race/ethnicity. The aggregate design effect for the under-65 population using the new MEPS sample design (2007) was 4.15, which was over 1.5 times higher than the aggregate design effect using the old sample design (2005 and 2006). The same general pattern can be seen within each of the race/ethnicity breakouts except for the Asians, whose design effect decreased under the new MEPS sample design – likely reflecting the more homogeneous weights for the Asians coming in from the NHIS with its over-sampling of Asians starting in 2006.

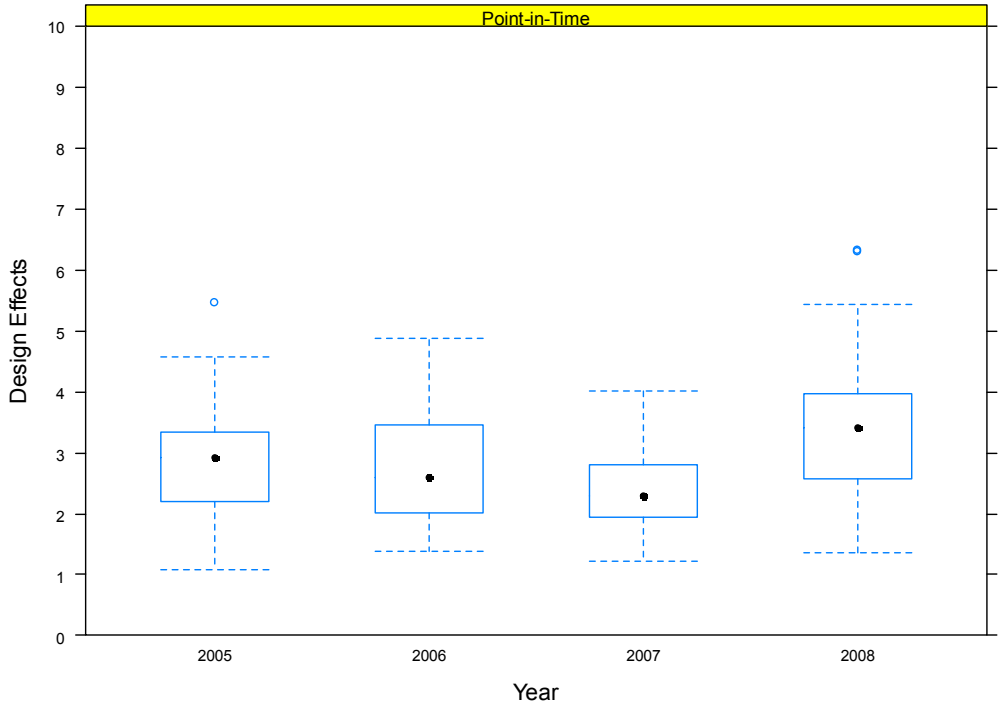
Table 5 – Impact of the MEPS Sample Redesign: Percent Uninsured for Persons Less Than 65 Years of Age (Year 1 Data)

	Sample Size (1,000's)			Design Effects		
Year	**2005**	**2006**	**2007**	**2005**	**2006**	**2007**
Aggregate	14.5	15.1	11.5	2.55	2.73	4.15
Hispanic	4.2	4.5	3.0	1.60	1.62	2.92
White only	6.7	7.0	5.6	3.28	3.44	4.10
Black only	2.6	2.6	2.0	1.44	1.54	2.16
Asian only	0.6	0.6	0.7	4.50	2.45	2.11

Point-in-Time (PIT) data can also be used to examine the impact of the MEPS sample redesign. PIT files include data collected in two different panels: Round 3 of the first year of a panel and Round 1 of the second year of the subsequent panel for a given survey year.

Figure 7 shows box plots of the distributions of design effects over the 36 subpopulations for estimates of the percent uninsured for persons under 65 years of age. For PIT data, 2007 was a mixed design year with one panel using the old MEPS sampling design and one panel using the new design. The 2008 PIT data were based on the totally new sample design. Interestingly, the mixed design year (2007) had the lowest median design effect (but largest number of PSU's) and the new design year (2008) had the highest median design effect. However, the distribution of design effects under the new MEPS sample design did not appear to be very different from the distributions under the old sample design. The design effects for the "mixed design" data file of 2007 were probably lower than the other years because for that file there were more variance estimation strata and PSU's due to having two different sample designs when creating that file.

Figure 7 – Distributions of Design Effects for Estimates of Percent Uninsured for Persons Less Than 65 Years of Age (PIT Data)



5. Summary

In summary, we have shown that the design effects in MEPS vary for different estimates and that they can vary greatly across demographic and socio-economic variables within the key analytical topics as well. We provided aggregate and median design effects for comparative purposes - though the take-away point is that despite the variation in design effects between the 36 subgroups, the medians and the variations of the design effects of the 36 subgroups for the estimates did not vary much from year to year. There was a general trend of lower design effects for over-sampled populations. However, this trend

was more obvious when examining estimates of total expenditures than when examining estimates of the percentage of persons under 65 years of age who are uninsured.

The MEPS sample redesign did not seem to have an impact on the design effects for the utilization measures. However, for the percentage of persons under 65 years of age who are uninsured, the sample redesign produced generally higher median design effects for these estimates. The apparently lower design effects for the "mixed design" year (2007 PIT) were probably due to the higher number of variance estimation strata and PSU's in the file due to having one panel using the old MEPS sample design and one panel using the new sample design. Design effects for the race/ethnicity subpopulations generally increased using the new sample design. The exception was the Asians, whose design effect decreased using the new sample design.

6. Discussion

The results of this study provide useful information for future MEPS sample allocation adjustments. However, additional analyses are needed because the full impact of the sample redesign is still not yet known. At the time of this study there was no Full Year data file available for analysis of expenditures that was constructed of panels that only used the new sample design. In addition, it would be prudent to examine other estimates as well as design effects from additional years of data. The possible impact of over-sampling changes in the NHIS was also not examined in this study. However, despite these caveats, valuable information was gleaned from examining the impact of the MEPS over-samples and survey redesign over the different survey years.

7. References

Cohen, S.B. (2000), "Sample Design of the 1997 Medical Expenditure Panel Survey Household Component". MEPS Methodology Report No. 11. AHRQ Pub. No. 01-0001. Rockville, MD: Agency for Healthcare Research and Quality.

Ezzati-Rice, T.M., Rohde, F., Greenblatt, J., *Sample Design of the Medical Expenditure Panel Survey Household Component, 1998-2007*. Methodology Report No. 22. March 2008. Agency for Healthcare Research and Quality, Rockville, MD.

"MEPS HC-105: 2006 Full Year Consolidated Data File" documentation. Agency for Healthcare Research and Quality. Center for Financing, Access, and Cost Trends. Rockville, MD. November 2008.

Shah, B.V., Barnwell, B.G., Bieler, G.S., Boyle, K.E., Folsom, R.E., Lavange, L., Wheeless, S.C., and Williams, R, Technical Manual: Statistical Methods and Algorithms Used in SUDAAN Release 7.0, Research Triangle Park, NC: Research Triangle Institute, 1996.