

## Sample Redesign and Conversion to Windows-Based Survey Instrument: Evaluation of Impact on Part-Year Estimates from the Medical Expenditure Panel Survey (MEPS)

Trena M. Ezzati-Rice<sup>1</sup>, Robert Baskin<sup>1</sup>, Huseyin Goksel<sup>2</sup>, Ralph DiGaetano<sup>2</sup>, Frederick Rohde<sup>1</sup>

<sup>1</sup>Agency for Healthcare Research and Quality (AHRQ), 540 Gaither Road, Rockville, MD 20850

<sup>2</sup>Westat, 1650 Research Blvd., Rockville, MD 20850

### Abstract

The MEPS is an ongoing longitudinal panel survey. A new panel is fielded annually and data are collected via five computer assisted personal interviewing (CAPI) interviews that cumulatively cover two consecutive years. Each annual MEPS panel is selected as a subsample of respondent households to the prior year's National Health Interview Survey (NHIS). In 2006, a new sample design was implemented for the NHIS and the changes carried over to the 2007 MEPS (MEPS Panel 12). Also, in 2007 the MEPS survey instrument was converted from a DOS-based system to a Windows-based system. These two changes have the potential to affect point estimates and standard errors of MEPS estimates. In this paper, we conduct an initial assessment of the impact of the changes on 2007 estimates.

**KEY WORDS:** sample weighting, poststratification, design effects

### 1. Introduction

The Medical Expenditure Panel Survey Household Component (MEPS-HC) is an ongoing complex national probability survey that has been conducted since 1996 by the Agency for Healthcare Research and Quality (AHRQ). Data collected in the MEPS-HC provide nationally representative estimates of health care use, expenditures, sources of payment, and insurance coverage for the U.S. civilian noninstitutionalized population. A key feature of the MEPS sample design is that each year's MEPS-HC sample is a subsample of households who participated in the previous year's National Health Interview Survey (NHIS) conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. Details of the NHIS-MEPS linked sample design have been previously published (Ezzati-Rice, TM, Rohde F, Greenblatt J, 2008). Using a subsample of NHIS households eliminates the need to independently list and screen households to locate selected policy-relevant subgroups of the population. The linkage also provides an additional data point for enhanced longitudinal analyses (Cohen SB, Makuc DM, Ezzati-Rice TM, 2007).

### 2. Overview of MEPS Sample Design and Panel 12 Sample Selection

In the MEPS, a new sample (panel) of households has been selected and fielded each year since 1996. Each new panel is interviewed five times over 30 months to yield health care information for two calendar years (Figure 1). Data collected in rounds 1, 2, and 3 of a given new panel provide information for the first calendar year associated with the panel. Data collected in rounds 3, 4, and 5 for the same panel provide information for the second calendar year associated with the panel. Round 3 for each MEPS panel overlaps two calendar years, thus, it provides data for both year 1 and year 2.

Starting in 1997, data from two overlapping panels are combined to increase statistical power of annual estimates produced from MEPS. More specifically, to produce health care estimates for a calendar year, data from the panel in its first year of data collection are combined with data from the prior year's panel and its second year of data collection. For example, 2001 annual estimates are represented by data from the second year of Panel 5 and data from year 1 of Panel 6.

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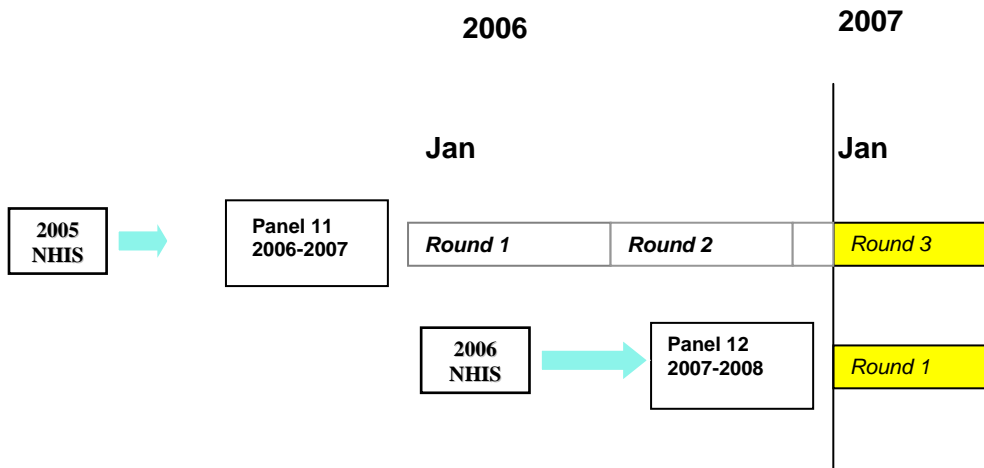
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Figure 1. MEPS Household Component Overlapping Panel Design

MEPS Panel	Year							
	1996	1997	1998	1999	2000	2001	2002	→
1	R1 R2 R3 R4 R5							
2		R1 R2 R3 R4 R5						
3			R1 R2 R3 R4 R5					
4				R1 R2 R3 R4 R5				
5					R1 R2 R3 R4 R5			
6						R1 R2 R3 R4 R5		
↓							R1 R2 R3	

In addition to annual estimates, the MEPS is designed to produce key estimates for the first half of the year for early release, again taking advantage of the overlapping panel design. The analysis in this paper focuses on data representing the first half of 2007. More specifically, data from the 2007 portion of the third Round of data collection for the MEPS Panel 11 sample are pooled with data from the first Round of data collection for the MEPS Panel 12 sample (see Figure 2).

Figure 2: 2007 MEPS First half of year



**2.1 2007 MEPS (Panel 12): What was New?**

As stated earlier, the set of households selected for each panel of the MEPS HC is a subsample of households participating in the previous year's NHIS conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. NHIS provides a nationally representative sample of the U.S. civilian noninstitutionalized population. Traditionally, the sample for the NHIS is redesigned and redrawn about every ten years. From 1995 to 2005 the NHIS used the same sample design. One feature of the NHIS design has been the oversampling of Blacks and Hispanics. MEPS began in 1996 with Panel 1 being a subsample of the 1995 NHIS responding households and the MEPS continued under the same NHIS design through Panel 11 (a subsample from the 2005 NHIS household

respondents). The NHIS employs the same sampled PSUs and sampled second stage sampling units (SSUs) each year. MEPS is selected from the same NHIS panels (two of the four available NHIS panels) each year and from the same two or three quarters of the year and thus is clustered within the same NHIS PSUs and virtually all of the same SSUs from one year to the next.

A new sample design for the NHIS was implemented in 2006, and, consequently, the features of the new NHIS sample design carried over to the 2007 MEPS. While the fundamental structure of the new 2006 NHIS sample design was very similar to the previous 1995-2005 NHIS sample design, the sample PSUs and second stage sampling units (SSUs) were selected independent of the sample selection process under the previous design. There was some overlap between the area populations covered by the sampled PSUs selected under the two designs, mostly the larger ones selected with certainty. There were two key features of the new 2006 NHIS sample design that affected the 2007 MEPS. First, the sampling PSUs and SSUs were independent of those selected under the previous design. With two independent samples a new set of variance strata and PSUs had to be developed for Panel 12 while the ones associated with the old design were retained for Panel 11. Thus, there are more variance strata and PSUs available for estimation purposes for the 2007 database than for previous years and, consequently, more degrees of freedom. Also, the degree of clustering of the sample was lessened for the 2007 database since the two independent MEPS panels were not sampled from the same set of PSUs and SSUs. As a result, with the reduction of the clustering of the sample, the 2007 standard errors are expected to be generally lower than they otherwise would have been were both panels associated with the same sample clusters. The second NHIS sample design enhancement that carried over to the MEPS included the addition of a new oversampling domain, namely, households with at least one Asian person. Previously, in the NHIS, only households with black and Hispanic persons had been oversampled.

There was another major change that occurred for the 2007 MEPS. The MEPS survey instrument underwent a conversion from Cheshire, a proprietary DOS-based system, to a windows-based system, Blaise/WVS, developed by Statistics Netherlands. The new windows-based system was implemented for Round 1 of Panel 12. Prior to fielding of the enhanced windows-based instrument, extensive pretesting was carried out. It should be noted, however, that minimal changes to the questions themselves were made. That is, for the most part, the MEPS computer assisted personal interviewing (CAPI) instrument was directly converted from DOS to the new windows-based Blaise.

As with any survey which implements changes in its sample and/or study design, it is important to evaluate the possible impact the changes might have on the survey estimates and field operations. Thus, the remainder of this paper focuses on a preliminary evaluation of the impact of the dual survey changes in 2007. In particular, we examine the impact of the new NHIS sample design on the MEPS sample design as well as examine the impact of both the new sample design and the new CAPI platform on the MEPS field operations. In addition, we summarize a preliminary evaluation of the impact on point estimates and variances and the impact on survey weights resulting from the new design.

### *2.1.1 Impact of new NHIS sample design on MEPS sample design*

The NHIS serves as the sampling frame for the MEPS and in most years, the MEPS annual sample is selected from among responding households in two of the four NHIS panels fielded during calendar quarters 1-3 of the previous year. However, to offset the burden associated with the dual introduction of a new sample design and new CAPI platform it was decided to reduce the sample size and to select the sample for the MEPS Panel 12 fielded in 2007 from among the responding households in only the first two quarters of the 2006 NHIS. This allowed AHRQ to provide the sample earlier to the data collection contractor, Westat, who subsequently could start an early start on identifying where new interviewers would need to be hired. Out of the 2006 eligible NHIS households, about 90 percent of the eligible units were selected. Overall, there were approximately 23 percent fewer dwelling units in the 2007 MEPS sample compared to 2006 (approximately 7,500 versus 9,700, respectively).

With the start of the 2007 MEPS, there was an increase in the total number of PSUs where sample cases were located. This was a result of the new sample design as well as the overlapping panel design and data collection scheme for MEPS. For example, during the first half of 2007, field interviewing was occurring for Panel 12 Round 1, Panel 11 Round 3, and Panel 10 Round 5. The total number of PSUs where sample was located was 250, an increase of 55 PSUs over prior years. A total of 46 new PSUs were fielded in Round 1 of the 2007 MEPS as a result of the new 2006 NHIS sample design. There were 102 PSUs that overlapped in the old and new MEPS design. The remaining 102 PSUs were the location of PSUs for the Panel 10 and 11 later rounds of interviews. This increase in PSUs will only be for 2007 where the MEPS sample stemmed from both the old and new NHIS sample designs. The MEPS design will be more clustered again in 2008 when both overlapping MEPS panels will be based on the new NHIS sample design.

### 2.1.2 Operational impact of new MEPS sample design and new CAPI platform

The conversion to the new windows-based CAPI coupled with the new sample design for Panel 12 had a direct impact on several operational aspects of the survey. The PSUs that were only in the new design had small workloads and many did not have an adequate number of sample cases to support a local interviewer, thus there was a need for more traveling interviewers. Additionally, the sample cases were more geographically dispersed, therefore requiring more driving time and increased hours per completed interview. In the new PSU areas, both interviewers and supervisors had to be hired. Further, the dual changes required an enhanced training protocol. Some interviewers required training only on the new windows-based application, while newly hired interviewers who would be interviewing for multiple rounds of the survey had to be trained on both the DOS and windows-based versions of the survey instrument. An additional complication was that some interviewers were required to conduct interviews using two different laptops (DOS-based and Windows-based) and to transmit data back to headquarters using two different systems. The field supervisors also had to use two different laptops for managing and assigning work. Post-Round 1 data collection showed a slight increase in the unweighted Round 1 response rate compared to Panel 11, Round 1, but, also observed was the less advantageous increase in interview administration time for the new windows-based instrument. This was likely compounded by new interviewers in the new PSUs.

## 3. Evaluation of the Impact of New Sample Design on the Survey Weights

Because of the sample linkage of MEPS and NHIS, the initial weight assigned to each MEPS dwelling unit is essentially the NHIS nonresponse adjusted household weight. This weight reflects several components of sampling including the original household probability of selection and the disproportionate sampling of minorities in the NHIS. The new NHIS sample design implemented in 2006 with its oversampling of Asians as well as blacks and Hispanics introduced additional variability in the 2007 MEPS base weights. There were also a number of unexpectedly large initial NHIS weights which seemed to be the result of NHIS segment subsampling rates that were extremely small. As a result, about 10 times as many base weights had to be trimmed for Panel 12, Round 1 compared to Round 1 of prior MEPS panels in order to limit variability in the MEPS weights.

### 3.1 MEPS analytical weights development

Weights are developed for use in the derivation of nationally representative estimates from the MEPS. The analytical weights typically account for any disproportionate probabilities of selection, unit nonresponse, person level survey attrition, and an adjustment to make the weighted sample distributions agree with known population estimates. This general approach is used in the MEPS (Wun LM, Ezzati-Rice TM, *et al*, 2007), including (1) an adjustment for dwelling unit nonresponse at Round 1 to account for nonresponse among those NHIS households subsampled for the MEPS, (2) an adjustment for nonresponse at the person level to account for survey attrition across the multiple rounds of data collection, and (3) a final step of poststratification or raking to known population totals for the civilian noninstitutionalized population of the United States.

Development of the person level weights for use with the analytical survey variables for the first half of 2007 followed the standard MEPS weights development strategy. More specifically, for the Panel 12, Round 1 participants, the weight reflects the initial NHIS weight as described above, an adjustment factor to represent the proportion of the 16 NHIS panel-quarter combinations eligible for MEPS, adjustment for oversampling of subdomains in the MEPS, a ratio adjustment to NHIS national population estimates at the household level, adjustment for MEPS dwelling unit (DU) nonresponse, and poststratification to population control totals (March 2007 CPS). Because of the unique sample linkage of the MEPS and NHIS, the variables used for the MEPS DU level adjustment include demographic, socio-economic, geographic, and health related variables as collected during the prior year's NHIS interview. These variables are available for both MEPS respondents and nonrespondents. As mentioned earlier, in order to make estimates for the first half of 2007, estimates from Panel 12, Round 1 are combined with those from Panel 11, Round 3. The final person weight used for analysis is thus a composite of the two separate panel specific weights. The individual Panel 11, Round 3 person level weight includes not only the adjustment for Panel 11, Round 1 DU level nonresponse but also an adjustment for person level survey attrition to compensate for Round 1 respondents who did not respond in Rounds 2 or 3. The Panel 11 weight also included a final raking to known CPS population totals.

## 4. Evaluation of the 2007 First-half of Year Survey Estimates and Variances

The key estimates that are released based on the MEPS point in time or first-half of year data files are estimates of health

insurance coverage, so the evaluation of the 2007 first half of year focused on the coverage estimates. More specifically, the evaluation included year to year (first half of year) comparisons of insurance coverage estimates (private, public only, and uninsured) and individual panel comparisons.

#### **4.1 Year to year comparison of insurance coverage**

Table 1 shows the results of comparing over time MEPS estimates of the percentage of people under 65 falling into three health insurance classes: private (at least partially covered by private health insurance); public only; and uninsured. Each MEPS estimate was for the first half of a given calendar year. Hypothesis testing indicated that both the estimated percentages of people with private insurance and those who were uninsured for the first half of 2007 were significantly different from the comparable figures for 2006. The private coverage rate in 2007 was lower than in 2006, while the uninsured rate in 2007 was higher than 2006. A similar comparison of estimates for the first half of 2006 with first half of 2005 did not show any significant differences within the three insurance coverage categories.

#### **4.2 Individual panel comparisons**

We also examined the two individual panel estimates that comprise the full combined first half of year estimates. Since Panel 12, Round 1 and Panel 11, Round 3 were both in the field at the same time, they were measuring the same population. However, Table 2 shows that the estimated percentage of the population privately uninsured was significantly lower for the 2007 Panel 12, Round 1 sampled participants compared to the 2007 Panel 11, Round 3 participants although both estimates pertained to the under 65 civilian, noninstitutionalized population. The same drop in private insurance in Panel 12, Round 1 versus Panel 11, Round 3, was observed for people under age 65. In contrast, the 2006 and 2005 individual panel comparisons of estimates (Panel 11, Round 1 versus Panel 10, Round 3 and Panel 10, Round 1 versus Panel 9, Round 3) did not show any significant differences within the three insurance categories. We examined some of the other variables available on the 2007 first half of year data file (health status, mental health status, employment status, and functional limitations) and as for health insurance coverage, several differences were observed between panels representing the same year.

### **5. Recalibration of the Initial 2007 First Half of Year Weight**

Because of the significant differences observed in the 2007 first half of year estimates (based on the weights initially constructed) compared to the comparable 2006 estimates and the particular concerns related to the individual panel differences, a rigorous investigation was carried out to determine if an appropriate adjustment could be implemented that would bring the insurance coverage estimates more in line with previous years and panels. This additional research was further encouraged by an examination of NHIS and CPS insurance coverage estimate trends from 2005 to 2007.

The primary criteria used in the research evaluation aimed at examining alternative weight adjustments and the impact on the insurance coverage estimates was that the process should be methodologically and statistically sound. Moreover, it should be able to be implemented in an expeditious manner in order to maintain the MEPS schedule for release of the 2007 first half of year public use file. The enhanced weighting adjustment strategy focused on modifying the Panel 12, Round 1 weight, namely, the Panel 12, Round 1 weight prior to its compositing with the Panel 11, Round 3 weight (and the poststratification of the composited weights to CPS control figures to form the final weights). In particular, the adjustment focused on carrying out an additional poststratification on variables related to insurance coverage. A number of variables from NHIS and CPS were examined to use in the poststratification process including: CPS employment status, NHIS income, NHIS poverty status, NHIS home ownership, NHIS insurance coverage (long term uninsured as well as two and three categories of coverage), combined NHIS insurance and CPS poverty status, combined NHIS insurance and home ownership, and combined NHIS insurance and educational level. Additional poststratification by age and race-ethnicity were also carried out. We also tried to poststratify the MEPS weights to CPS by poverty status. However, because of the definitional differences in identifying family members between CPS and MEPS, poverty status could not be used directly in poststratification. Instead modeling approaches were tried. A regression model, predicting the poverty levels using the CPS data, was developed. The predictors entered into the model included: race and ethnicity, age, gender, employment status, level of education, census region, MSA status, family type, family size, and marital status of the person. The R-square for the model was 0.32. The quintiles of the distribution of the predicted poverty levels were determined. The weighted estimate of the number of persons in each quintile was computed using the CPS data to be used as a control total to poststratify the MEPS weights. Next, the regression coefficients estimated from the CPS model were applied to the MEPS data to produce predicted poverty levels from MEPS. Finally, the MEPS weights were poststratified within poststratification classes that were formed by grouping these predicted values based on the quintiles obtained from CPS. Another modeling approach researched made use of the MEPS data to develop a model to predict

the proportion of persons with poverty status at 300 percent or above of the poverty level. An Automatic Interaction Detector (AID) type of modeling algorithm was used. The predictors entered into the model included level of education, employment status, race and ethnicity, age, gender, family type and size, region and MSA status. The predictive cells identified by the model were used as poststratification classes to poststratify the MEPS weights to the CPS controls.

### 5.1 Evaluation of the Final Recalibrated Weight

The poststratification adjustment that would have likely been most beneficial was one that included income or poverty status. However, actual poverty status information is not available on the MEPS data files representing the first half of a given year and therefore cannot be used directly for poststratification purposes for the weights appearing on such files. (It should be noted that poverty status is available later for the development of the final full year MEPS weight and it is used at that point for the poststratification.) Thus, in the end, an additional level of poststratification for the Panel 12, Round 1 MEPS respondents was employed which reflected the 2006 NHIS population distribution across age (less than age 65 and 65 and older) and insurance status categories (private and other). This was possible since Panel 12, Round 1 MEPS respondents are associated with a 2006 NHIS responding household. The modified final Panel 12, Round 1 panel specific weight was combined with the already developed Panel 11, Round 3 panel specific weight. Then, a final poststratification was undertaken across the variables of census region, MSA status, race/ethnicity, sex, and age to form the final weight for each responding person. The final recalibrated weight brought the 2007 first half of year coverage estimates more in line with first half of year estimates from previous years. In particular, among the total U.S. civilian noninstitutionalized population as well as those under 65, the percent uninsured during the first half of 2007 did not differ significantly from the comparable figures for 2006.

## 6. Assessment of Design Effects Associated with Weight Variation

As with any survey where selected domains have been oversampled, the precision of the estimates for the population as a whole as well as for domains not oversampled is reduced compared to what would have been obtained had the sample been proportionally allocated across the population. This is due both to the reduction in sample sizes for the under sampled domains and the variation in the sample weights for the population as a whole and many subpopulations. Specifically, differential sample weights will arise in any subpopulation whose members were not all sampled from the same sample domain and thus whose sampling rates varied. Nonresponse and calibration (poststratification or raking) adjustments can also contribute to the variability of the weights. The coefficient of variation (CV) of a weight variable can be used to compute a corresponding design effect, which in turn can be used to measure the impact on survey estimates resulting from the variation in the survey weights. Dividing the number of survey respondents by the design effect associated with weight variation indicates the size of a simple random sample that would provide the same level of precision as the current design (assuming no impact on the variance due to clustering). The design effect associated with the variation of the weights can be calculated as  $(1 + CV^2)$  (Korn and Graubard, 1999).

Table 3 provides estimated design effects associated with weight variation over several years of MEPS. These design effects are only for Round 1, that is, the first round of data collection for the newest panel fielded in a given calendar year. Comparing the design effects of the initial versus final weights for 2007, it can be seen that the nonresponse and final calibration adjustments had only a minor effect on the variation of the weights. However, the design effects were lower in 2007 compared to earlier years for the overall population, Hispanics, blacks, and persons of all other races. The differences appear relatively sizeable for all groups except “all other races”. In comparison, the design effect increased for Asians which would be expected since Asians were oversampled in the NHIS starting in 2006 which carried over to the 2007 MEPS.

## 7. Assessment of Design Effects Associated with Survey Estimates

Weighted estimates were calculated by age, sex, and race/ethnicity, along with corresponding estimated standard errors (SEs), relative standard errors (RSEs), and design effects for all variables available on the 2007 first of half of year data file. These estimates were computed for the combined panels (Panel 12, Round 1 and Panel 11, Round 3) as well as for Panel 12, Round 1 only. The same sets of estimates and corresponding estimates of variability were calculated for the 2006 first of half of year data file for the combined panels (Panel 11, Round 1 and Panel 10, Round 3) as well as for Panel 11, Round 1 separately. Average design effects were then computed across all variables and subgroups for the 2007 and 2006 combined panels, for the 2007, Round 1 estimates alone, and for the 2006, Round 1 estimates alone. The ratio of these average design effects are shown in Table 4. The ratio of the average design effects for the combined

panels is 0.88. A ratio less than 1 is consistent with the reduction in the design effects associated with less clustering in the 2007 MEPS compared to the 2006 MEPS. As discussed earlier, the 2007 MEPS consisted of subsamples of NHIS household respondents from two independent national samples of households due to the NHIS sample design change in 2006. The 2007 MEPS sample was thus fielded in many more sample PSUs and roughly twice as many segments, reducing the degree of clustering substantially compared to that for the 2006 MEPS where the sampled households for both Panels 11 and 10 were subsamples from the same set of NHIS PSUs and segments. The degrees of freedom for MEPS 2007 estimates are also expected to be generally greater than those available for 2006 due to the large number of variance strata and PSUs (328 and 731, respectively) compared to 2006 (203 strata and 452 PSUs). This reduction in design effects and increase in degrees of freedom is a feature unique to 2007 since the MEPS sample stemmed from both an old and new NHIS sample design. The MEPS design will again be more clustered in 2008 when both MEPS panels will be based on a single NHIS sample design. The potential factor(s) driving the differential in the ratio of the average design effects for Panel 12, Round 1 versus Panel 11, Round 1 at 1.05 is still under investigation.

## 8. Discussion

The MEPS sample design reflects multiple analytical goals and as with any survey which implements changes in its sample and/or study design, the impact of the changes on key survey estimates needs to be evaluated. With the dual survey changes that were implemented in the 2007 MEPS, it is difficult to definitively separate out the effects of the new sample design and the new windows-based data collection platform. Most of the evaluations to date have focused on the impact of the new sample design. In particular, based on a comparison of initial first half of year estimates for 2007 with previous years' first half of year estimates, as well as comparison of estimates between panels representing the same year, the results indicated that the Panel 12, Round 1 person weight might benefit from an additional level of poststratification. The recalibration of the initial Panel 12, Round 1 weight did provide improvements. However, even with the final recalibrated weight, some important differences still exist for first half of year 2007 with panels combined and between the two individual panels within the same year. Thus, future research will include an in-depth analysis of the impact of the intersection of the new sample design, new PSUs, new interviewers, and the new windows-based survey instrument. Additional evaluations will be carried out when the 2007 full year data become available at which time health care utilization and expenditure estimates, income, and other variable can be examined.

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**Table 1: Year to Year Comparison of Insurance Coverage Estimates, people under age 65: first half of 2007 versus first half of 2006 and first half of 2006 versus first half of 2005**

Yr to Yr Comparison	Private	Public Only	Uninsured
1st half 2007 compared to 1st half 2006	Significantly lower	NS	Significantly higher
1st half 2006 compared to 1st half 2005	NS	NS	NS

**Table 2: Individual panel comparisons of insurance coverage estimates within year: 2007, 2006, 2005**

	Private	Public Only	Uninsured
2007 (initial wt) Panel 12, Round 1 vs. Panel 11, Round 3	Significantly lower	NS	Significantly higher
2006 Panel 11, Round 1 vs. Panel 10, Round 3	NS	NS	NS
2005 Panel 10, Round 1 vs. Panel 9, Round 3	NS	NS	NS

**Table 3: Design effect (1+CV<sup>2</sup>) associated with variance of person level weights by race/ethnicity, first half of year MEPS data files, Round 1: 2002-2007**

	Overall	Hispanic	Black	Asian	Other
2007 (Final weight)	1.347	1.312	1.294	1.334	1.203
2007 (Initial weight)	1.335	1.301	1.281	1.336	1.201
2006	1.438	1.701	1.353	1.202	1.232
2005	1.437	1.623	1.320	1.202	1.227
2004	1.458	1.669	1.377	1.244	1.249
2003	1.398	1.552	1.437	1.259	1.205
2002	1.480	1.729	1.534	1.194	1.233

**Table 4. Ratio of average design effects (deff) across all variables and by age, sex, race/ethnicity**

	Ratio of average deffs
2007 first half of year (combined panels) versus 2006 first half of year (combined panels)	0.88
2007 (Panel 12, Round 1) versus 2006 (Panel 11, Round 1)	1.05