DESIGN EFFECT VARIATION IN THE MEDICAL EXPENDITURE PANEL SURVEY (MEPS)

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Introduction

The sample design of the 1996 Medical Expenditure Panel Survey(MEPS) is characterized by a multistage, complex area probability design that includes disproportionate sampling of specified policy relevant population groups. Standard methods of variance estimation which assume simple random sampling generally result in an under-estimation of variance, when used with data from a complex survey design (Cohen S., 1982). The extent of this departure from simple random sampling assumptions and its impact on the variances of survey estimates may be measured by the design effect. The design effect is defined as the ratio of the true variance of a statistic to the variance derived under simple random sampling assumptions. Based on data from the Household Component of the 1996 MEPS, design effect variations on estimates of health care utilization and insurance coverage was reported (Yu, W., 1999). This paper will further evaluate the design effects achieved for national estimates of health care expenditures and sources of payment, the level of design effect variation in related survey estimates, and design effect variation by alternative population subgroups and by different geographic regions of the nation.

Design of the MEPS Household Component

The 1996 MEPS Household Component (HC), a nationally representative survey of the U.S. civilian noninstitutionalized population, collects medical expenditure data at both the person and household levels. The HC collects detailed data on demographic characteristics, health conditions, health status, use of medical care services, charges and payments, access to care, satisfaction with care, health insurance coverage, income, and employment. The survey is sponsored by the Agency for Health Care Research and Quality(AHRQ) with co-sponsorship by the National Center for Health Statistics(NCHS).

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The 1996 MEPS HC sample was selected from households that responded to the 1995 National Health Interview Survey (NHIS). This selection consists of 195 Primary Sampling Units (PSUs), 1,675 sample segments (second-stage sampling units) and 10,597 responding households. It is designed to produce unbiased estimates for the four Census regions, with over-sampling of households with Hispanics and blacks at a ratio of approximately 2.0:1 for Hispanics and 1.5:1 for blacks. The average design effect target for survey estimates of health care use and expenditure estimates for the 1996 MEPS was 1.6 (Cohen S., 1997).

The 1995 NHIS response rate achieved for MEPS-eligible households was 93.9 percent. Of 10,639 responding NHIS dwelling units eligible for MEPS, 99.6 percent were identified with enough information to allow MEPS data collection. Of the11,424 eligible reporting units targeted for interviews in Round 1, 9,488 (83.1 percent) responded. Overall, the joint NHIS-Round 1 response rate for the 1996 MEPS household survey was 77.7 percent (.939 x .996 x .831).

The MEPS HC uses an overlapping panel design in which data are collected through a preliminary contact followed by a series of six rounds of interviews over a 2 ½-year period. Using computer-assisted personal interviewing (CAPI) technology, data on medical expenditures and use for 2 calendar years are collected from each household. This series of data collection rounds is launched each subsequent year on a new sample of households to provide overlapping panels of survey data and, when combined with other ongoing panels, will provide continuous and current estimates of health care expenditures (Cohen J., 1997).

Source and Definition of Data

This study is based on the 1996 full year use and expenditure data file (MEPS HC-011). Expenditures on this file refer to what is paid for health care services. More specifically, expenditures in MEPS are defined as the sum of direct payments for care provided during the year, including out-of-pocket payments and payments by private insurance, Medicare, Medicaid, and other sources. Payments for over the counter drugs and for alternative care services are not included in MEPS total expenditures. Indirect payments not related to specific medical events such as Medicaid Disproportionate Share and Medicare Direct Medical Education subsidies, are also not included.

The expenditure data included on this file were derived from the MEPS HC and Medical Provider Components(MPC). MPC data were collected for some office-based visits to physicians(or medical providers supervised by physicians), hospital-based events (e.g. inpatient stays, emergency room visits, and outpatient department visits), and prescribed medicines. HC data were collected for nonphysician visits, dental and vision services, other medical equipment and services, and home health care not provided by an agency while data on expenditures for care provided by home health agencies were only collected in the MPC. MPC data were used if complete; otherwise HC data were used if complete. Missing data for events where HC data were not complete and MPC data were not collected or complete were derived through an imputation process(Cohen S. and Carlson B., 1994).

Design Effect

Given the complex nature of the 1996 MEPS HC survey design, the assumptions of independence and equal selection probabilities are not satisfied. Its impact on variance estimation is best described as follows:

$$\sigma^2_{complex} = \sigma^2_{SRS} [1 + \rho (\tilde{n} - 1)]$$

where

$\sigma^2_{complex}$ is the true variance of a statistic given the complex survey design,
σ^2_{SRS} is the variance estimate obtained for the statistic under sample random sampling assumptions,
ρ is the intra cluster correlation coefficient, and
$\tilde{n}$ is the average cluster size.

The design effect is consequently expressed as:

$$\text{Design Effect} = (\sigma^2_{complex} / \sigma^2_{SRS}) = [1 + \rho (\tilde{n} - 1)]$$

The design effect deviates from unity when the effects of clustering are dominant in a survey design and the average cluster size is moderate to large. Variances of all estimated parameters presented in this paper were derived using the Taylor series linearization method to account for survey design complexities (shah, 1996).

Evaluation of Design Effect Variation

Based on the 1996 MEPS HC data, design effects are determined for a representative set of 40 survey statistics which estimate health care expenditures and sources of payment of the U.S. population. For the nation, the design effects ranged from 0.77 for the estimate of total zero-night stays expenditure to 5.18 for the estimated proportion of total expenditure paid by Medicaid with an overall average of 1.86. Figure 1 is a bar chart comparing the level of design effects, sorted in ascending order, achieved for a subset of national estimates of health care expenditures and sources of payment.

Demographic variables used to form population subgroups in this analysis include gender (male, female), age (<19, 20-44, 45-64, 65+), race/ethnicity (Hispanic, black/non-Hispanic, others), and Census region (Northeast, Midwest, South, West).

Figure 2 presents a comparison of average design effects from the selected health care expenditures and sources of payment measures across all the alternative population groups and by different geographic regions of the nation. Overall, age group 65+ has the lowest average design effect at 1.29 while the Hispanic group has the highest average design effect of 2.08. The average design effects for males and females appear to be similar at 1.57 and 1.61 respectively. There is a notable downward trend for the value of average design effect by ascending age group. The average design effect is highest at 1.73 for age group 0-19 and lowest at 1.29 for age group 65+. For the census regions, persons living in the Northeast had the lowest average design effect at 1.60 and those in the South had the highest at 1.92.

The following subset of representative medical expenditure and source of payment measures were selected for a more detailed study of design effect variation:

- Total health care expenditures in 1996,
- Total office-based (physician + Non-physician + Unknown) expenditures in 1996,
- Total Rx-expenditures in 1996,
- Total outpatient expenditures in 1996,
- Total inpatient expenditures in 1996,
- Proportion of total expenditures paid by self/family, and
- Proportion of total expenditures paid by private insurance.

For each of the selected variables, domain estimates were generated in terms of population means. The domain estimates are defined by marginal or cross-classified distributional categories of the selected demographic variables. For example, for the mean total

Figure 1 - Design Effect for Mean Estimate of Medical Expenditures and Sources of Payment Measures from the 1996 MEPS - National Average

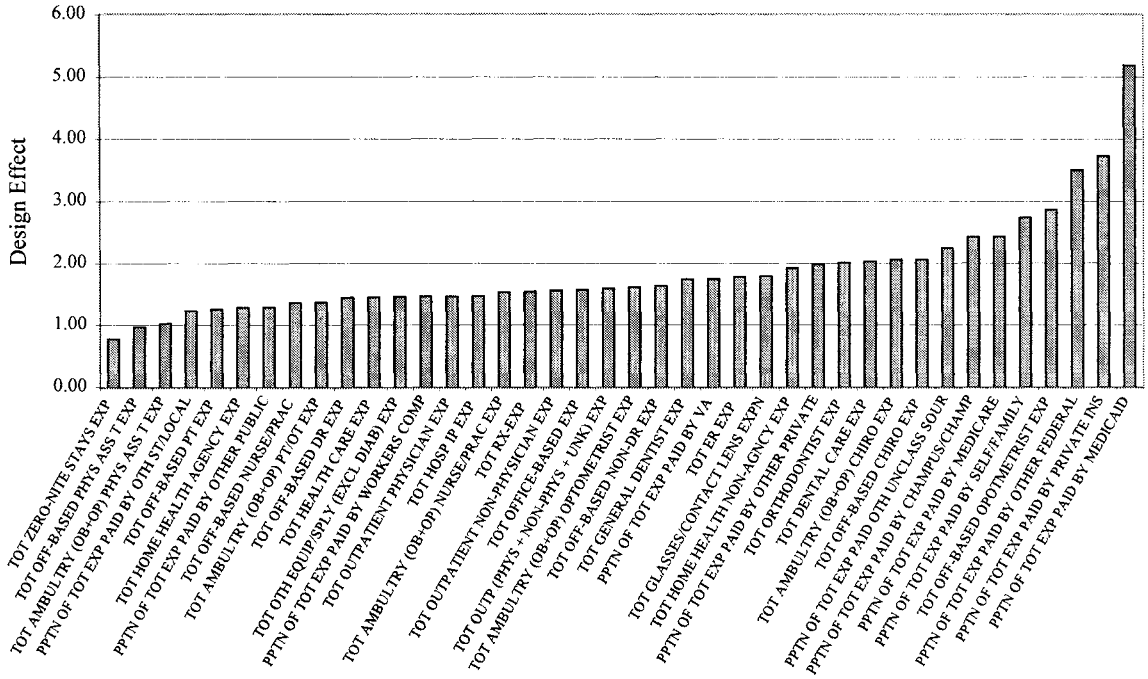
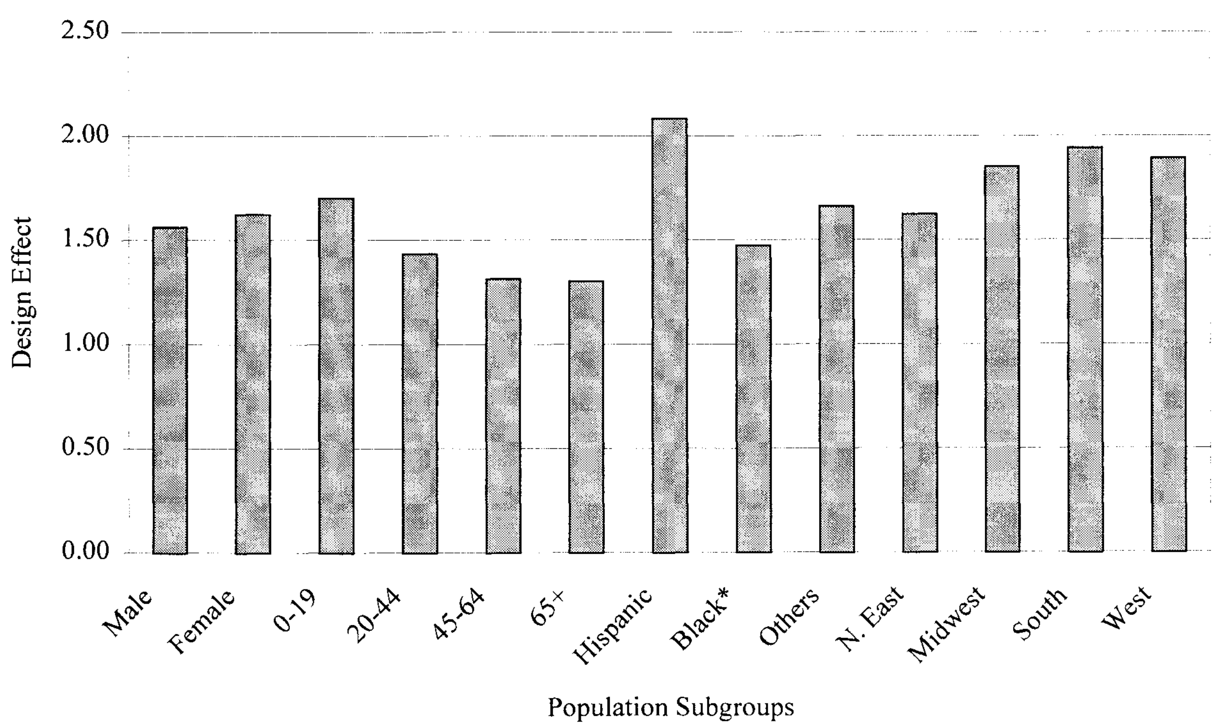


Figure 2 - Average Design Effect for Alternate Population Subgroups



Data Source: 1996 MEPS HC-011, *non-Hispanic inpatient expenditures within specific age-race/ethnicity-sex-census region classes of the U.S. population, the domain estimate, $\overline{Y}_g$, is derived as:

$$\overline{Y}_g = (\Sigma_i W_i X_{gi} Y_i) / (\Sigma_i W_i X_{gi})$$

where

Y_i is the i^{th} individual's total inpatient expenditures,
W_i is the i^{th} individual's sampling weight,
X_{gi} = 1 if the individual is a member of the g^{th} age-race/ethnicity-sex-census region domain,
= 0 otherwise.

The quartile boundaries on sample size for the set of domain estimates under investigation were cross-classified by the quartile boundaries on the resultant mean estimates of the respective health care expenditure and source of payment measures, yielding sixteen strata. Within each of these strata and their marginal classes, the average design effect and the standard error of the design effect were derived.

The most notable pattern in design effect variability was the positive incremental effect of sample size on the value of average design effect. As shown in Figure 3, the pattern was most obvious for domain estimates of the proportion of total expenditures paid by private insurance. The average design effect ranged from 1.44 (SE = .062) on sample size less than or equal to 132, to 2.41 (SE = .14) for sample size greater than 979. Similar, but more moderate, patterns were observed for the other selected health care expenditure and source of payment measures. This pattern of positive incremental effect was also reported in an earlier study of design effect variation on health care utilization and insurance measures (Yu, 1999). No distinct relationship was observed (Figure 4) between the average design effect and the respective quartile boundaries which characterized the distribution of criterion variable domain estimates.

Further analysis consisted of the specification of an underlining linear model of average design effects as a function of the main effects of sample size and criterion variable boundaries and the interaction between them, the determination of whether any of the model effects were significant, and the assessment of the statistical significance of different sources of variation in the data through a partition of model components. This was implemented using a SAS General Linear Model procedure (PROC GLM) for each of the representative measures.

Figure 3 - Positive Incremental Effect of Sample Size on the Values of Average Design Effect

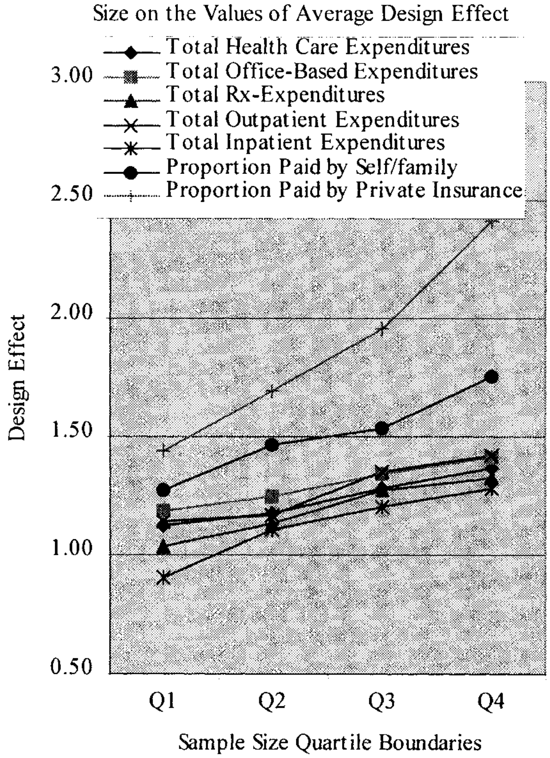
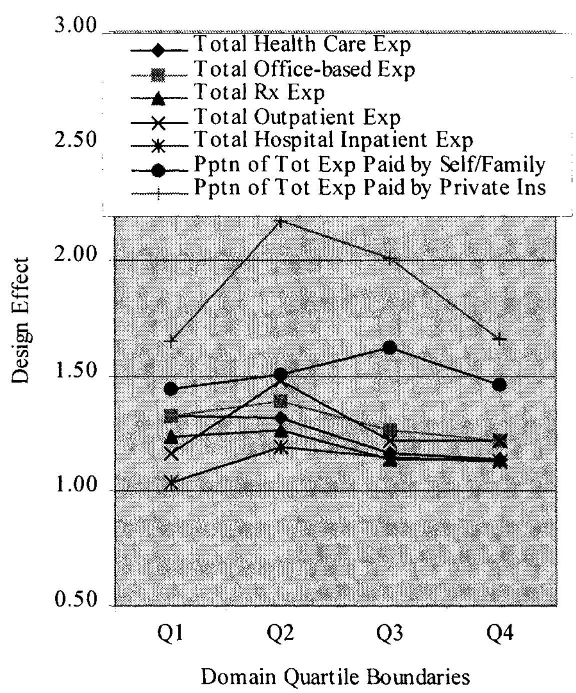


Figure 4 - No Distinct Relationshp Between the Values of Average Design Effect and Domain Quartile Boundaries



Tables 1.1 -1.7 contain summaries of the SAS output including source of variation(Source), degree of freedom(DF), and the p-values for testing the significance of the model, the main effects (sample size and domain estimate), and their interaction. P-values derived from type I sum of squares(SS) and type III SS are both presented to allow for assessments of the effects in order of inclusion and for assessing specific effects after controlling for all other factors.

The results presented in tables 1.1 to 1.7 show that the overall model specified for each of the selected variables is significant at the 0.05 level. Thus, at least one of the effects (sample size and/or domain estimate) is significant. No significant interaction effects were evident between sample size and domain estimate boundaries characterizing design effect variability except for the proportion of total expenditures paid by private insurance. For each of these representative measures, a significant main effect was noted between design effect variation and sample size. The only exception is that the effect of sample size is non-significant (P = 0.0643) after controlling for all other factors. In contrast, a significant main effect between design effect variation and domain estimate boundaries was not observed for data on total expenditures for office-basedvisits, total expenditures for prescribed medicines, total hospital inpatient expenditures, and proportion of total expenditures paid by self/family. For data on total health care expenditures, total outpatient expenditure, and proportion of total expenditures paid by private insurance, a significant main effect was observed between design effect variation and domain estimate boundaries. However, the differences are not incremental (Figure 4).

Summary

The study findings revealed that the original average design effect target for the 1996 MEPS for mean estimates of total health care expenditures, total hospital inpatient expenditures, total expenditures for prescribed medicines, total outpatient expenditures, and total emergency room expenditures generally was satisfied.

Overall, for the selected health care expenditures and source of payment measures, the average design effects are approximately the same between gender but varied appreciably between race/ethnicity groups (Hispanics vs. blacks/others), age categories (<45 years old vs. >= 45 years old), and among Census regions.

Positive incremental effects on the average design effect were observed in relation to sample size for all the selected variables. A statistically significant main effect was observed between design effect variation and domain estimate boundaries for several of the selected variables.

Table 1.1 - Total Health Care Expenditures

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	0.0014		
Sample Size	3		0.0029	0.0263
Domain Mean	3		0.0114	0.0254
Interaction	9		0.1863	0.1863

Table 1.2 - Total Office-based Expenditures

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	0.0300		
Sample Size	3		0.0107	0.0643
Domain Mean	3		0.1181	0.0886
Interaction	9		0.3400	0.3400

Table 1.3 - Total Rx Expenditures

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	<0.001		
Sample Size	3		< 0.001	< 0.001
Domain Mean	3		0.1219	0.1236
Interaction	9		0.2150	0.2150

Table 1.4 - Total Outpatient Expenditures

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	< 0.001		
Sample Size	3		< 0.001	0.0060
Domain Mean	3		0.0011	0.0070
Interaction	9		0.1339	0.1339

Table 1.5 - Total Hospital Inpatient Expenditures

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	< 0.001		
Sample Size	3		< 0.001	< 0.001
Domain Mean	3		0.1802	0.2286
Interaction	9		0.3841	0.3841

Table 1.6 - Proportion of Total Expenditures (Paid by Self/Family)

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	<0.001		
Sample Size	3		< 0.001	< 0.001
Domain Mean	3		0.0939	0.0945
Interaction	9		0.4305	0.4305

Table 1.7 - Proportion of Total Expenditures (Paid by Private Insurance)

Source	DF	Pr > F	Pr > F(I)	Pr > F(III)
Model	15	< 0.001		
Sample Size	3		< 0.001	< 0.001
Domain Mean	3		< 0.001	< 0.001
Interaction	9		0.0420	0.0420

However the effects were not incremental. The statistically significant interaction effect between sample size and domain estimate, characterizing design effect variability for the proportion of total expenditures paid by private insurance, merits additional study. One possible explanation is that the ultimate cluster units in the 1996 MEPS HC sample design are the household or family. It is to be expected that a strong positive correlation exists between individuals in the same household with respect to their source of payment for medical expenditures.

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