Estimates of Medical Expenditures from the Medical Expenditure Panel Survey: Gains in Precision from Combining Consecutive Years of Data

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Introduction

The Medical Expenditure Panel Survey (MEPS) is a complex national probability survey of the civilian noninstitutionalized population that has been conducted on an annual basis since 1996 by the Agency for Healthcare Research and Quality (AHRQ). One of the primary purposes of the survey is to collect data that can be used to analyze national medical expenditures (i.e. the amount paid for health care services). In addition to the complex sample design (i.e. stratification, clustering, weighting), factors that affect the precision of MEPS estimates of medical expenditures include the sample sizes for the analytic subgroups of interest and the highly skewed distribution of medical expenses (e.g. in 1996 the top 1 percent of the population accounted for 27 percent of aggregate expenditures, see Berk and Monheit, 2001). As a consequence of these factors, some point estimates for particular subgroups of the population may show substantial fluctuations from one year to the next that are not statistically significant.

MEPS data can be combined across years to improve the precision of estimates and expand the types of analyses possible. This paper uses selected examples based on data from the first few years of MEPS to illustrate the extent to which gains in precision can be achieved by combining consecutive years of data. Analytic and methodological considerations when combining MEPS data across years are also discussed.

Sample Design of the MEPS Household Component

The sample of households for the MEPS Household Component (HC) is a subsample of households that responded to the prior year's National Health Interview Survey (NHIS) conducted by the National Center for Health Statistics. The 1995-2004 NHIS sample design is based on a sample of approximately 7,000 segments (i.e. clusters of housing units) from 358 primary sampling units (counties or groups of counties). The NHIS oversamples Blacks and Hispanics and has a targeted annual sample yield of about 44,000 respondent households containing 106,000 persons in the U.S. civilian non-institutionalized population (National Center for Health Statistics, 2002). While sample households change from year to year, the NHIS is designed so that the sample PSUs remain the same from 1995-2004.

The MEPS sample is drawn from approximately half of the PSUs selected for the NHIS. For example, the 1996 MEPS Household Component (HC) sample was selected from households that responded to the 1995 NHIS. This selection was comprised of 195 Primary Sampling Units (PSUs) and 1,675 sample segments (second-stage sampling units). Over-sampling of households with Hispanics and blacks (at ratios of approximately 2.0:1 and 1.5:1, respectively) carries over from the NHIS to the MEPS sample design.

The sample design of the Medical Expenditure Panel Survey (MEPS) is an overlapping panel design, with data collected for each new MEPS sample (panel) covering a two-year period (Cohen, 1997). As a result of the overlapping panel design, MEPS annual data for 1997 and beyond are constructed based on data collected from two different sample panels.

While MEPS annual data for 1996-98 are based on a sample of about 195 PSUs, the design for the fourth MEPS panel (new 1999 sample) was based on a reduced sample of about 100 PSUs. Consequently, part of the sample used to produce 1999 annual data is based on a 100 PSU design (i.e. first year of 1999 panel) while the other part is based on a 195 PSU design (i.e. second year of 1998 panel).

MEPS Expenditure Data

Total medical 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 hospital and physician services, ambulatory physician and nonphysician services, prescribed medicines, home health services, dental services, and various other medical equipment and services that were purchased or rented during the year are included. Payments for over the counter drugs, alternative care services, and phone contacts with providers are not collected in MEPS.

MEPS expenditure data are derived from the Household (HC) and Medical Provider Components (MPC) of the survey. The MPC obtained data from some medical providers on the amounts paid and sources of payment of medical events they were associated with that were reported in the HC (Machlin and Taylor, 2000). Missing expenditure data for health care events reported in the survey were derived through a weighted hot deck imputation process, with data from the MPC used as the primary donor source wherever possible. Imputations are based on the setting of care and /or type of provider, with appropriate correlates of expenditures used to match donor with recipient records. Missing data for prescribed medicines were imputed based on a complex matching procedure (Moeller et al, 2001).

Methods

This study is based on data from the first 4 MEPS annual consolidated public use data files (file HC-012 for 1996, HC-020 for 1997, HC-028 for 1998, and HC-038 for 1999 are available at www.meps.ahrq.gov). To illustrate the impact on precision of average expenditure estimates by combining years, we compare the precision of annual estimates for individual years to those for combined consecutive two-year (1996-97, 1998-99) and four-year periods (1996-99) for three different groups (all ages, children under 6, and Asian/Pacific Islander children under 6). Summary sample sizes for each of the analytic groups (unweighted and weighted) are shown in Table 1. All estimates presented in this paper are weighted and standard errors were computed using a Taylor Series approximation to account for the complex survey design. Combined estimates can be interpreted as annual averages (weighted by population sizes) for the multi-year period being combined. Because the MEPS annual files used for the analysis do not contain a consistent coding structure for the same PSUs across years, we appended a consistent coding structure for the sample design variables after combining the four annual files for analysis (obtained from file HC-036, available at www.meps.ahrq.gov).

Results

All Ages (Table 2)

In the first four years of MEPS, total sample sizes ranged from 21,571 in 1996 to 32,636 in 1997 (Table 1). MEPS estimates of average expenses for the entire U.S. civilian noninstitutionalized population based on these sample sizes were fairly similar each year (ranging from $2,038 in 1996 to $2,156 in 1999) and these annual estimates were fairly precise, with relative standard errors (RSEs) of approximately 3 percent each year (see Table 2). The average design effect for annual MEPS estimates for 1999 was approximately 2 (Yu, 2003), indicating that the standard error of the estimates were about 40 percent higher (i.e., $\sqrt{2}$) than what would be expected from a simple random sample of the same number of sample observations.

Combining years only modestly improves the relative precision of national expenditure estimates. For example, the RSEs for combined estimates for the 1996-97 and 1998-99 periods were between 2 and 3 percent (versus about 3 percent for annual estimates) while the RSE associated with the estimate for the combined 4 year period (1996-99) improved slightly to 1.9 percent (Figure 1).

While estimates of expenditures for the entire U.S. are fairly precise based on individual years of MEPS data, combining annual data becomes an attractive option to reduce the level of sampling error, ameliorate erratic fluctuations over time, and/or expand the potential for analyses of small subpopulations. The results in the next two sections illustrate this point.

Children under 6 (Table 3)

In the first four years of MEPS, approximately 10 percent of the sample were children under 6 years of age with sample sizes for this subpopulation ranging from 2,018 in 1996 to 3,082 in 1997 (Table 1). The MEPS estimate of average expenses for children under 6 was notably higher for 1996 ($1,052) than for the three subsequent years ($755, $793, and $874, respectively, Table 3). However, the RSE for the 1996 estimate was about 15 percent and the RSEs for the other three years' estimates were only slightly lower (12-14 percent). While an overall test of trend across the four years was not significant (p=.38), the difference between 1996 and 1997 was borderline statistically significant (p=.09).

Combining years to produce national estimates for children produces noteworthy improvements in the precision of estimates. The RSEs for combined estimates for the 1996-97 and 1998-99 periods were about 10 percent while the RSE associated with the estimate for the combined 4 year period (1996-99) declined to 6 percent (Figure 2). As a result, point estimates for the combined periods are substantially more stable and confidence intervals are substantially narrower than for individual years. The estimated change in average annual expenses between the combined two-year periods (i.e., 1996-97 and 1998-99) was a decline of $70, and this estimated change was highly non-significant (p=.60).

Asian/Pacific Islander children under 6 (Table 4)

To illustrate the impact of combining years to produce MEPS expenditure estimates for extremely small population subgroups, Table 4 provides estimates for

Asian/Pacific Islander children less than 6 years of age. The sample sizes for this group ranged from 58 in 1996 to 93 in 1999 (Table 1). These sample sizes are lower than the minimum standard of 100 for producing estimates that is applied by the Center for Financing, Access, and Cost Trends at AHRQ. Nevertheless, we use this population subgroup to demonstrate gains in precision and improved feasibility of publishing estimates for small population subgroups by combining years of MEPS data.

As shown in Figure 3, the relative standard error was 21 percent or larger for each of the 4 annual estimates, but was especially large for the 1996 estimate (43 percent). Combining data for 1996-97 resulted in an RSE of 29 percent while the RSE for the combined 1998-99 period was 19 percent. While these RSEs reflect some improvement in precision, they remain fairly large. Moreover, the RSE for the combined four year period was only slightly lower than for the combined estimate for 1998-99 (18 versus 19 percent, respectively).

Discussion

MEPS annual expenditure estimates are very reliable for the total U.S. civilian noninstitutionalized population and large subpopulations. Consequently, combining data is generally not necessary except when analyzing small subgroups. In particular, analysts need to take into consideration the potential sensitivity of estimates to extremes, especially for small subgroups. For example, analysts working with 1996 and 1997 data may conclude that there had been a decline in average expenses for children under 6 between 1996 and 1997 (estimated change =-$297, p=.09). Even if this difference had been significant at the conventional .05 level, it should be interpreted with caution because there is no reason evident for such a dramatic shift in children's expenses in consecutive years, and expenditure estimates are sensitive to extremes due to the skewed distribution of the variable (Figure 4). To illustrate this sensitivity, eliminating only one observation with a high expenditure value produces a substantial change in the p-value associated with the significance test comparing average expenses for children under 6 in 1997 versus 1996. If the observation with the highest expenses in 1996 is eliminated (thereby reducing the 1996 sample for children under 6 from 2,018 to 2,017 observations), the p-value for this comparison shifts upward from .09 to .17. However, the p-value shifts downward from .09 to .06 if the observation with the highest expenses in 1997 is eliminated instead (thereby reducing the 1997 sample for children under 6 from 3,082 to 3,081 observations). These fluctuations indicate that the results can be substantially affected by only one observation in the upper tail of the distribution, even in samples as large as 2,000-3,000 observations. This sensitivity is also revealed by the fact that even though the estimated averages for children in 1996 and 1997 were dramatically different ($1,052 versus $755), estimated median expenses for those years were virtually identical ($196 versus $194).

Combining multiple years of data will often have the benefit of improving precision and can make it possible to produce estimates for small subgroups of the population, but requires the tradeoff of moving from annual to "average annual" estimates covering longer periods. Moreover, having the same sample PSUs in MEPS each year and about half of the same sample persons across two consecutive years due to the overlapping MEPS panel design may attenuate the gains in precision that would be expected from combining independent samples. Nonetheless, the importance of improving the precision of particular estimates or producing an estimate for a small subdomain may well outweigh these limitations. For example, in our analysis the estimated average annual expenses for Asian/Pacific Islander children under 6 for the combined period from 1996-99 was about $525, with a 95% confidence interval spanning from $335 to $715. While this confidence interval is not extremely narrow, combining years produced an estimate that meets the AHRQ minimum statistical standards for publication of MEPS estimates (see Table 1 footnote). As another example, there are a limited number of sample persons each year in MEPS who die during the survey period. Combining MEPS data for 1996-99 made it possible to analyze end of life expenses for both the elderly and non-elderly populations (Machlin et. al, 2002.). In summary, combining samples to produce national expenditure estimates for young Asian/Pacific Islander children and for persons at the end of life are just two examples of the types of small subgroup analyses made possible by combining multiple years of MEPS data.

There are situations where a policy change could produce noticeable shifts in a short period of time that combining consecutive years of data would suppress. For example, MEPS data for 1996, 1998, and 1999 were used to show significant decreases in expenditures for home health care paid by Medicare that were likely attributable to the 1997 Balanced Budget Amendment (Spector et. al., 2002). Despite the fact that some of the differences between the 1996 and 1998 annual estimates were statistically significant, the authors combined data for 1998-99 in order to increase the reliability of the estimates and strengthen the overall analysis.

Beginning in 2002, MEPS sample sizes have been increased and the sample design incorporates oversampling of Asian/Pacific Islanders and persons with low income. These changes will enhance the ability of MEPS to produce reliable annual expenditure estimates for a broader range of population subgroups.

In addition, the variance estimation variables in MEPS Public Use files will be developed based on a consistent coding structure, which will facilitate combining years by making it unnecessary to obtain standardized variance estimation variables from a separate file. In the meantime, MEPS data users need to be aware that in order to obtain appropriate variance estimates, combining years from 1996-99 requires linkage to a file that provides a common variance estimation coding structure (file HC-036, available at www.meps.ahrq.gov).

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Table 1. MEPS Household Component: Unweighted and Weighted Sample Sizes[1]

	All Ages		Children under 6		Asian/Pacific Islander Children < 6	
Year(s)	Unweighted sample size	Weighted population size (mils.)	Unweighted sample size	Weighted population size (mils.)	Unweighted sample size	Weighted population size (mils.)
Annual						
1996	21,571	268.91	2,018	23.86	58	0.90
1997	32,636	271.28	3,082	23.79	78	0.85
1998	22,953	273.53	2,114	23.73	82	0.93
1999	23,565	276.41	2,156	23.85	93	1.07
Combined 2-years						
1996/97	54,207	270.09	5,100	23.83	136	0.88
1998/99	46,518	274.97	4,270	23.79	175	1.00
Combined 4-years						
1996/97/98/99	100,725	272.53	9,370	23.81	311	0.94

Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

[1]The Center for Financing, Access, and Cost Trends (CFACT) at the Agency for Healthcare Research and Quality (AHRQ) has responsibility for the MEPS and applies the following statistical standards when publishing annual expenditure estimates from MEPS:

(1) The minimum unweighted sample size is 100,
(2) Estimates with relative standard errors greater than .30 are identified with an asterisk to indicate reliability concerns with the estimate.

The intent of these criteria are to help insure that underlying normality assumptions for statistical tests are satisfied given the skewed distribution of medical expenses and to minimize the likelihood of disseminating unreliable estimates.

Table 2. Mean Expenditures for the Total Population: MEPS

Year(s)	Estimated Mean	S.E. of Mean	RSE
Annual			
1996	$2,038	$68	0.0334
1997	$2,039	$59	0.0287
1998	$2,049	$64	0.0310
1999	$2,156	$68	0.0315
Combined 2-years			
1996/97	$2,039	$48	0.0233
1998/99	$2,103	$56	0.0268
Combined 4-years			
1996/97/98/99	$2,071	$39	0.0189

Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

Table 3. Mean Expenditures for Children Ages 0 to 5: MEPS

Year(s)	Estimated Mean	S.E. of Mean	RSE
Annual			
1996	$1,052	$157	0.1490
1997	$755	$89	0.1177
1998	$793	$103	0.1299
1999	$874	$121	0.1385
Combined 2-years			
1996/97	$904	$94	0.1038
1998/99	$834	$80	0.0957
Combined 4-years			
1996/97/98/99	$869	$54	0.0624

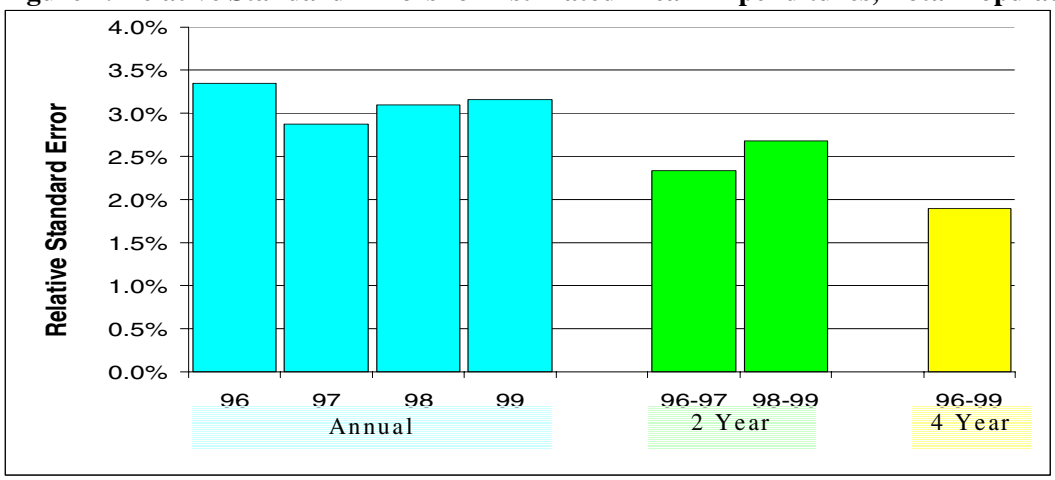
Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

Table 4. Mean Expenditures for Asian/Pacific Islander Children Ages 0-5: MEPS

Year(s)	Estimated Mean	S.E. of Mean	RSE
Annual			
1996	*	*	0.4325
1997	*	*	0.2109
1998	*	*	0.2777
1999	*	*	0.2279
Combined 2-years			
1996/97	$529	$156	0.2945
1998/99	$522	$99	0.1898
Combined 4-years			
1996/97/98/99	$525	$97	0.1846

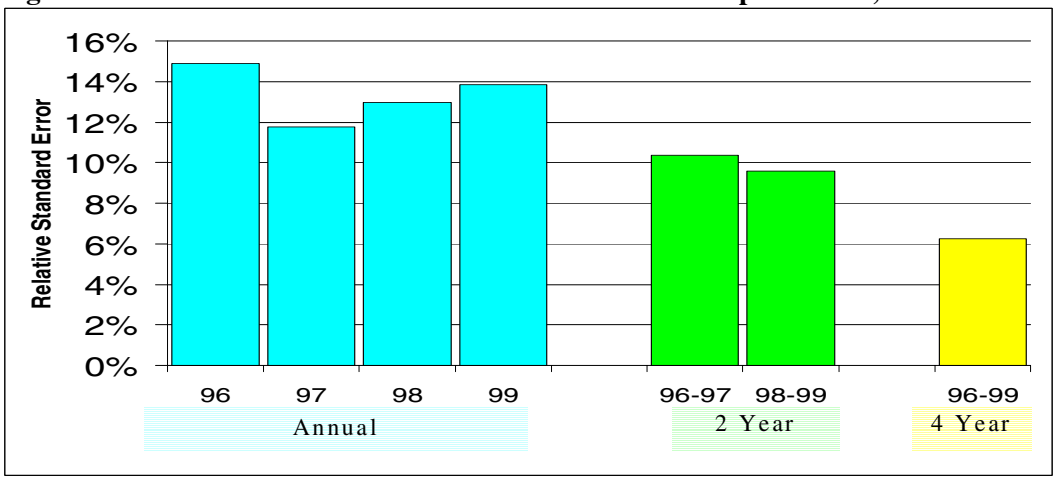
*Estimates not shown due to small sample sizes (less than 100).
Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

Figure 1. Relative Standard Errors for Estimated Mean Expenditures, Total Population: MEPS



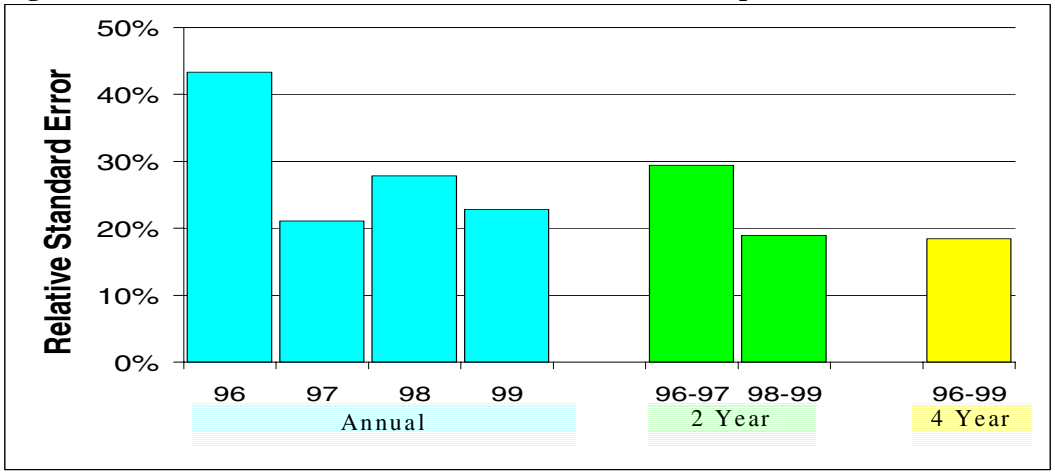
Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

Figure 2. Relative Standard Errors for Estimated Mean Expenditures, Children 0-5: MEPS



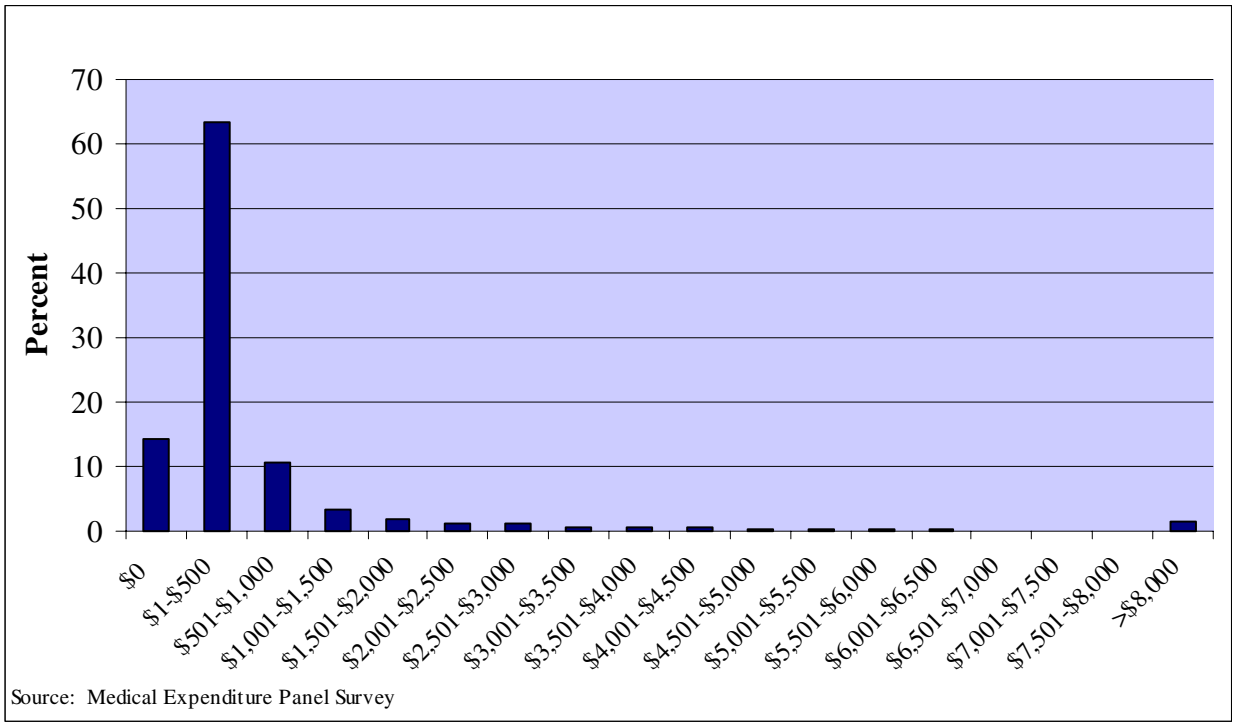
Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

Figure 3. Relative Standard Errors for Estimated Mean Expenditures, API Children 0-5: MEPS



Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality

Figure 4. Frequency Distribution of Annual Healthcare Expenditures for Children in Sample Under 6 Years of Age, 1996-1999: MEPS



Source: Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality