ALTERNATIVE OPTIONS FOR STATE LEVEL ESTIMATES IN THE NATIONAL MEDICAL EXPENDITURE SURVEY

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1. INTRODUCTION

The increased national focus on issues related to health care reform has served to reinforce the demand for reliable estimates of health care measures that characterize the health care experience of individuals at both the national and state level. Federally sponsored health care surveys have been designed to meet the needs of government agencies, legislative bodies, and health professionals for the comprehensive national estimates needed in the formulation and analysis of national health policies. These national health care data collection efforts are generally limited, however, in their capacity to produce reliable estimates at the sub-national level. While direct estimates can often be derived at the census region or census division level, sample size requirements and budget constraints typically preclude the capacity for the derivation of state level estimates.

As the trend toward state-specific experimentation with health care financing reform continues, the demand for expanding the scope of national health care surveys to also provide direct state specific estimates will grow in concert. This study examines the issues associated with this anticipated trend, by considering a range of alternatives for developing a more complete state level database as part of a large national health care survey. More specifically, the health care data collected in the 1987 National Medical Expenditure Survey (NMES-2) provides a rich source of information to support analyses assessing the health care experience of individuals at the national and regional levels (Edwards and Edwards 1989; and Cohen, DiGaetano and Waksberg, 1987). Because the sample design for NMES-2 did not specifically include a requirement for the derivation of state estimates, the analyses that can be supported by the NMES-2 data at the state level are seriously constrained.

This paper summarizes the limitations of the 1987 design with respect to deriving state estimates of health care parameters. The NMES-2 sample representation within states is also examined. Then, the study examines the data collection considerations for a range of alternative designs that would enhance the capacity for producing state level estimates of health care parameters obtained through the 1996 NMES-3.

2. NMES-2 STATE LEVEL SAMPLE REPRESENTATION

As noted, the sample design of the NMES-2 did not specifically include a requirement that would allow for the derivation of state level health care estimates that satisfied fixed precision specifications. Table 2 presents a distribution of all states in the nation classified by population size based on 1990 population data. The data indicate that over 56 percent of the U.S. population reside in the ten states with the largest populations. Furthermore, the data indicate that only 3 percent of the U.S. population reside in the ten states with the smallest populations. Table 2 also presents a summary of the number of counties within each of the states associated with a given population size classification, further distinguished by Metropolitan Statistical Area (MSA) status. The data indicate that over 34 percent of the counties in the ten states with the largest population had MSA classifications (312 out of 902). Alternatively, only 7.5 percent of the counties in the ten states with the smallest populations were so classified (22 out of 292 counties).

Approximately 53 percent of the responding NMES-2 sample were selected from the largest 10 states in the nation. Within the smallest 10 states in the nation, the sparseness of the sample representation at the person and dwelling unit levels is evident. For example, only 2.5 sample respondents were selected to represent non-MSA areas in the 10 states with the smallest population size. A comparison of the NMES-2 sample

representation in contrast to the U.S. population distribution, further cross-classified by state grouping based on the dimension of population size, revealed a relatively coincident pattern in distributions .

A summary of the NMES-2 state level representation, further distinguished by the number of sample PSUs, is presented in Table 4A. As before, when a NMES-2 PSU consisted of a group of contiguous counties that were in more than one state, the PSU was assigned the dominant state classification based on the sample size representation. An initial review of the state level representation of the NMES-2 sample, based on the 165 primary sampling units (PSUs) selected to represent the nation, revealed that not all 50 states were drawn into the sample to represent the nation. More specifically, 10 states had no sample PSUs selected in NMES-2, and one additional state was covered by only a single PSU with negligible sample representation (PSU cross-state boundaries). In addition, 7 states were represented by only a single PSU, with another 14 states contributing either 2 or 3 PSUs to the NMES sample. Of the remaining 18 states that were associated with 4 or more sampled PSUs, only 7 were characterized by the selection of at least 2 non-MSA PSUs and at least 2 MSA PSUs, which was viewed as the minimal number necessary to allow for reliable estimates at the state level.

Since the NMES-2 sample design represented a union of two independent national household samples respectively selected by Westat, Inc. and NORC, a number of the sampled PSUs represented the same distinct sites. To allow for a more careful investigation of the number of distinct sites selected at the PSU level, PSUs from the two data collection organizations that represented the same county or groups of contiguous counties were identified as a single area. This process of examining overlapping counties that were selected into both the Westat, Inc. and the NORC NMES-2 national samples resulted in the identification of 130 separate areas. Table 4B provides a summary of the NMES-2 state level representation, further distinguished by the number of separate areas at the PSU level selected into the sample. While the general pattern observed for the state level representation with respect to sample PSUs, a more noteworthy observation could be made when considering the unique ares covered by sample PSUs. Of the 14 states that were associated with 4 or more unique areas covered by sampled PSUs, only 4 were characterized by the selection of at least 2 non-MSA PSUs and at least 2 MSAs, which was viewed as the minimal number necessary to allow for reliable estimates at the state level (with the exception of New Jersey, whose counties were all characterized as MSAs).

In a prior study on alternative options for enhancing the representation of rural areas in NMES-3 it was determined that a sample of 550 dwelling units with 1,469 individuals selected from 7 primary sampling units would be necessary to achieve an average relative standard error of .10 that served as a summary of the reliability achieved for survey estimates of the health care measures under consideration (Cohen, Braden and Ward, 1991). As a consequence of the seriously limited NMES-2 sample representation from the perspective of state level estimation, particularly with respect to the sparse number of sample PSUs within covered states, reliable estimates at the state level, as measured by an average RSE of .10, could be obtained from NMES-2 for only a subset of the ten largest states. In order to determine the required sample size necessary to satisfy precision specifications for state level estimates of the health care measures obtained in NMES, it was necessary to consider an alternative sample design analysis that was not dependent on unreliable state level estimates. Consequently, the sample design analysis that examined the precision of NMES-2 survey estimates was conducted at a higher level of geographical aggregation than the state level. Within a given census division, the precision level achieved by the NMES-2 design was examined and served as a benchmark to model the necessary sample size modifications required to achieve alternative precision levels. The resultant sample size specifications determined to satisfy a desired precision level for survey estimates were then applied to each of the states within a given census division. An adjustment was made for the expected reduction in the survey design effect attributable to sampling individuals within a state rather than at the census division level. Table 5 also provides a summary of the precision levels that were achieved in NMES-2 for survey estimates that represent the

population residing within distinct census divisions. All but two of the census divisions were characterized by average relative standard errors below .10, indicating a capacity to produce reliable NMES estimates of health care parameters at this level of geographical aggregation.

3. SPECIFICATIONS FOR FUTURE NMES SAMPLE DESIGN OPTIONS

Having summarized the analytical capabilities and limitations of the current NMES-2 design, we can now specify a range of alternative designs that would yield estimates of greater precision at the state level in NMES-3. The strategy for developing this set of alternative designs was to build upon the NMES-2 design without any loss in precision for the overall sample or any of the population subgroups targeted for oversampling in NMES-2. To ensure that this design requirement was achieved, all of the alternative design options were developed as augmentations to the 1987 sample with no offsetting sample reductions. Furthermore, it was assumed that the primary sampling units would be sampled according to a probability proportional to sample size (pps) selection scheme and stratified by their MSA/non-MSA classification. To improve the representativeness of the state level sample, an additional design specification was imposed that required the selection of a minimum of two non-MSA PSUs per represented state.

Within this framework, four alternative sample design enhancements were considered for developing a more complete state level database in the future as part of the 1996 NMES-3. The precision level achieved by the NMES-2 design within a given census division served as a benchmark to model the necessary sample size modifications required to achieve alternative precision levels. The resultant sample size specifications determined to satisfy a desired precision level for survey estimates at the census division level were then applied to each of the states within a given census division. An additional adjustment was made for the expected reduction in the survey design effect attributable to sampling individuals within a state rather than at the census division level. The adjustment was based on a comparison of the design effects achieved for survey estimates of the health care measures under consideration produced at the census division level, and for a subset of the largest states. As a consequence, it was assumed that the expected reduction in the survey design effect attributable to sampling within a state rather than at the census division level was ten percent (with a fifteen percent reduction specified for state level estimates for the West South Central Census Division).

3.1 Option A: Reliable Estimates for the Ten Largest States

This option builds upon the NMES-2 design with a sample expansion to facilitate the derivation of reliable health care estimates for the ten largest states. Approximately 56.4 percent of the U.S. population resides in the ten largest states. As a consequence of the large representation of the overall U.S. civilian non-institutionalized population residing in these state, a sample expansion to permit this capacity for state level estimates is analytically desirable. For each state, the survey design was required to achieve an average relative standard error of .10 for health care estimates that characterize the resident population.

The required level of sample augmentation necessary to satisfy the precision requirement of an average relative standard error of .10 was determined in the following manner. For a given state, the level of precision achieved in survey estimates at the associated census division level was examined and adjusted downward for the expected reduction in the survey design effect attributable to sampling individuals within a state rather than at the census division level. The sample size determination was then based on this adjusted measure of precision. In order to satisfy this precision requirement for the largest state, California, it will be necessary to obtain a sample of at least 1,513 responding individuals.

Based on NMES-2 data, the average number of responding individuals per dwelling unit was approximately 2.614 for the Pacific Census Division. Consequently, it will be necessary to obtain 579 responding dwelling units to satisfy the precision level requirement. Since an average of 78 responding dwelling units will be selected from each primary sampling unit, it will be necessary to select a minimum of 7 PSUs and 252 segments to represent the state of California. Under a probability proportionate to sample size sample allocation scheme for the selection of PSUs within

the state, it is unlikely that a single non-MSA PSU would be selected. To improve the representativeness of the state level sample, an additional design specification was imposed that required the selection of two non-MSA PSUs. Table 6 provides a detailed summary of the desired sample in both California and the other nine largest states in the nation, at all stages of selection, to satisfy the requirements of Option A.

As a consequence of the large sample size required to achieve an average relative standard error in survey estimates of .1 in the states of the West South Central Census Division (Texas, Oklahoma, Louisiana and Arkansas), even with the inclusion of the assumption of a 15 percent expected reduction in the survey design effect attributable to sampling individuals within a state rather than at the census division level, the precision requirement was modified to an average relative standard error .125 . It is immediately evident from Table 6 that the level of sample size augmentation to yield state level health care estimates for the desired level of precision is modest for New York, Florida and Pennsylvania. Since the state of New Jersey only has MSA PSUs, all of the required sample size increase was concentrated in metropolitan areas. In summary, the NMES-3 sample design modifications necessary to permit state level estimates for the ten largest states requires a sample size enhancement of 6,000 individuals associated with 2,273 dwelling units, and the addition of 41 primary sampling units which include 9 non-MSA counties.

3.2 Option B: Reliable Estimates for a Ten State Option

Option B allows for separate state level estimates for the six largest states in addition to four states of particular health care policy interest. The four additional states selected under this option, which included Oregon, Arkansas, Minnesota and Vermont, were meant to be representative of states that command particular attention from a health policy perspective. Each of these states is a participant in the Robert Wood Johnson Foundation's new program, "State Initiatives in Health Care Financing Reform", designed to help states plan and develop significant health care financing and delivery changes that will help expand health care coverage for the uninsured while containing costs. Furthermore, the four states that were selected are located in distinct Census Regions.

For each state included in this NMES-3 design option for reliable estimates at the state level, with the exception of the states within the West South Central Census Division, the survey design was required to achieve an average relative standard error of .10 for the health care estimates under consideration (RSE = .125 for Texas and Arkansas). In order to satisfy this precision requirement for this NMES-3 sample design option, it would be necessary to obtain a sample of at least 20,068 responding individuals associated with 7,427 dwelling units residing in 94 separate areas (counties). Table 7 provides a detailed summary of the desired sample for each of the ten states under consideration, at all stages of selection, to satisfy the requirements of Option B. It is immediately evident from Table 7 that the overall level of sample size augmentation to yield state level health care estimates for the desired level of precision under Option B is noticeably higher than the sample size enhancement necessary to satisfy Option A. This is a function of the substitution of the four policy relevant states that have smaller populations with a greater rural concentration than their counterparts in Option A. Furthermore, one of the states under consideration, had no residents selected into the NMES-2 sample. Under a probability proportionate to sample size sample allocation scheme for the selection of PSUs within states, both the states of Arkansas and Vermont were expected to have a modal sample representation of non-MSA PSUs. In summary, the NMES-3 sample design modifications necessary to permit state level estimates for this ten state option requires a sample size enhancement of 9,330 individuals associated with 3,420 dwelling units, and the addition of 53 primary sampling units which include 19 non-MSA counties.

3.3 Option C: Reliable Estimates for all Fifty States

Option C is an expansion of the scope of the first two, providing a capacity to derive reliable health care estimates separately for each of the 50 states. For each state included in this NMES-3 design

option for reliable estimates at the state level, with the exception of the states within the West South Central Census Division, the survey design was required to achieve an average relative standard error of .10 for the health care estimates under consideration (RSE = .125 for Texas, Oklahoma, Louisiana and Arkansas). While this option provides the strongest analytical capacity relative to all the sample design options under consideration, it requires a major sample design enhancement that is greater than the overall NMES-2 sample size.

To satisfy the precision requirement associated with the 50 state design option, it would be necessary to obtain a sample of 389 PSUs and 5,299 segments, yielding approximately 31,794 responding dwelling units and 84,176 responding individuals in NMES-3. Table 8 provides a detailed summary of the desired sample, at all stages of selection, to satisfy the requirements of Option C. Given the sparse number of counties in the states of Delaware, Rhode Island and Hawaii, the required number of sample PSUs to support state specific estimates was specified at three. Furthermore, it should be noted that the state of New Jersey is characterized by only metropolitan counties. From the table, it is immediately evident that only a modest sample size augmentation would be necessary to permit state level estimates for all states in the Middle Atlantic Division (New York, New Jersey and Pennsylvania). Alternatively, the largest sample size enhancement would be necessary within states that comprise the West South Central Division. This was not unexpected, given the greater variation in survey estimates that characterizes the West South Central Census Division from the remaining Divisions.

In summary, the NMES-3 sample design modifications necessary to permit state level estimates for this fifty state option requires a sample size enhancement of 54,592 individuals associated with 20,660 dwelling units, and the addition of 263 primary sampling units which include a minimum of 70 non-MSA counties. Inclusion of the District of Columbia in this design option to permit separate estimates with an average relative standard error of .10, will require an additional sample of 779 individuals within approximately 300 dwelling units.

3.4 Option D: Obtain State Level Health Care Estimates By Model-Based Small Area Estimation Strategies

Option D is a sample design enhancement entirely separate from the preceding three options. It requires a NMES-3 design modification to improve the accuracy of state level estimates derived by application of model-based small area estimation strategies to NMES data, without an explicit design requirement for the derivation of direct state level health care estimates. In order to clarify the sample design modifications necessary to best support this estimation strategy, the underlying model assumptions associated with this estimation strategy are presented.

The small area estimation strategy under consideration is a model-based approach developed by the National Center for Health Statistics (Braden and Cohen, 1992). The basic assumption is that within a given socio-demographic or economic population subgroup, a state level estimate of a health care measure of interest is coincident to a estimate derived from a health care survey at the Census region or division in which the state is located. It is recognized that this is a strong underlying model assumption. Demographic information such as age, race, sex and income, which define the population subgroups or domains, must be available at the state level. Furthermore, the health care measure under consideration must be strongly associated with the measures that define socio-demographic/economic subgroups. Domains are formed by cross-classifications of these socio-demographic/economic measures. To derive a synthetic state level estimate for the criterion measure of interest, Y(s), a survey estimate (Y(d)) of the health care measure is required for each of the D domains. The final synthetic estimate of a health care criterion measure of interest for state s is derived as the weighted average of Y(d) across all domains, where the weight is the proportion of the population of state s that is classified in domain d. To the extent the host survey has an estimation capacity to produce both unbiased and reliable estimates at the Census Division level, the synthetic estimates of the criterion measure of interest derived using domain estimates at this level of geographic aggregation for member

states are more likely to coincide with state population values, than a synthetic estimation strategy based on domain estimates derived at the Census Region level. Consequently, the recommended NMES-3 design modification to improve the accuracy of state level estimates derived by application of model-based small area estimation strategies, is the inclusion of an estimation capacity to produce unbiased estimates at the Census Division level with improved reliability over the level achieved in NMES-2. For each of the nine Census Divisions, this survey design modification would require the achievement of an average relative standard error of .10 for the health care estimates under consideration (.125 for the South West Central Division) . A relative standard error specification of .10 would ensure that a 95 percent confidence interval around the estimate would be approximately 20 percent of the estimate. To improve the representativeness of the Census Division level samples, an additional design specification was imposed that required the selection of a minimum of two non-MSA PSUs per Division.

A review of the summary of the precision levels that were achieved in NMES-2 at the Census Division level presented in Table 5 revealed that all but two of the nine census divisions were already characterized by average relative standard errors below .10 . Furthermore, all but two of the divisions were characterized in NMES-2 by the selection of at least two non-MSA PSUs. A redistribution of the NMES-2 sample of 34,459 individuals, 13,015 dwelling units and 130 distinct areas, would allow both the precision and non-MSA coverage specifications to be met for each Census Division with no required sample size augmentation.

4. DISCUSSION

Because of budgetary considerations, NMES-2 was not designed to produce state level estimates. To improve upon existing design limitations, four alternative sample design enhancements to the NMES-3 have been considered as options for improving the survey's capacity to yield reliable health care estimates for state level populations. The first three design enhancements are incremental in nature, both in terms of scope and related survey costs, with each enhancement identifying a design limitation that does not currently meet a desired analytical objective. The first two design options, which permit state level estimates for the ten largest states (Option A) or ten policy relevant states (Option B), require only modest sample size augmentation to the NMES-3 overall sample to satisfy analytical objectives. While the 50 state option (Option C) provides the strongest analytical capacity relative to all the sample design options under consideration, it requires a major sample design enhancement that is greater than the overall NMES-2 sample size. Alternatively, the fourth design enhancement (Option D) requires design modifications targeted to improving the accuracy of state level estimates derived by application of model-based small area estimation strategies to NMES data, without an explicit design requirement for the derivation of direct state level health care estimates. While no sample size augmentation is necessary to satisfy this design option, the level of accuracy achieved for resultant state level estimates is particularly dependent on underlying model assumptions. (Note: Tables and References available from the author). The views expressed in this article are those of the authors and no official endorsement by the Dept. of Health and Human Services or the Agency for Heath Care Policy and Research is intended or should be inferred.