STATE ESTIMATES FOR THE NATIONAL HEALTH INTERVIEW SURVEY

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INTRODUCTION

The National Health Interview Survey (NHIS) is designed to produce reliable annual estimates of the civilian noninstitutionalized population for the Nation and for each of the four Census Geographic regions (see Massey et al, 1989). Although the NHIS is not designed to yield estimates for individual geographic States (i.e., the 50 States and the District of Columbia), the NHIS will yield State estimates.

This paper reports on the initial results of research to determine for which individual geographic States, if any, the NHIS could be used to produce reliable estimates. The research was limited to design-based methods. The research provided some evidence that the NHIS could be used to produce reliable design-based estimates for a handful of the largest States.

STATE ESTIMATES FROM A NATIONAL DESIGN

Stratification and States. In the NHIS a primary sampling unit (PSU) is one or more counties or a (consolidated) metropolitan statistical area. These PSUs are grouped into sampling strata within the four Census Regions of the U.S. by metropolitan status, using a clustering algorithm. State membership is not a factor in forming strata.

Figure 1 displays four of the non-self representing (NSR) strata of the West region. As can be seen, a stratum can be quite geographically dispersed throughout a Region. A stratum may straddle several States, and a State may straddle several strata.

The large metropolitan areas are designated as self representing (SR) strata. The SR strata, while tending to be contiguous, may straddle several States. For example, the Chicago-Gary-Lake County (IL), IL-IN-WI Consolidated Metropolitan Statistical Area, a SR PSU, straddles Illinois, Indiana, and Wisconsin.

Modeling generic coefficients of variation. To gauge the level of sampling variability we hypothesized coefficients of variation (CVs) for generic estimates of proportions over State subdomains of interest. For such an estimator, $\hat{p}$,

we model

$$CV(\hat{p}) = \text{sqrt}[(1-p)/(p\,n)]\ \text{deft}\quad (*)$$

where n = sample size of the domain
p = true proportion of domain with the characteristic

$$\text{deft}^2 = \text{Var}(\hat{p}|\text{complex design})/\text{Var}(\hat{p}|\text{Simple Random Sample})$$

The NHIS design geographically clusters both the first and second stage sampling units. Experience with NHIS data shows that with this clustering a hypothesized deft between 1 and 2 probably provides adequate bounds for the CV of expression (*) for most characteristics of interest. Accepting a 10 percent CV as a standard in defining an estimator reliable, and considering the smallest p of interest to be .10, necessitates a sample size of 1000 for a variable which has slight correlation with the design (e.g., deft = 1.05) and a sample size of 3600 for a variable with a high correlation with the clustering (e.g., deft = 2).

Most NHIS analyses are done in subdomains, typically defined in terms of age, sex, and race. In this research we used coarser subdomains in order to identify States where some analysis, albeit crude, could be undertaken. Note we believed that a minimum precision requirement of a ten percent CV for a 10 percent estimate was reasonable, given the coarse subdomain definitions. In Tables 1 to 4 some hypothesized State CV's for a 10 percent subdomain characteristic are presented for the State subdomains: All persons, persons ages 18-64 (work force subdomain), Blacks ages 18-64, and Hispanic ages 18-64.

Using the 10 percent CV rule, we see from table 1 that 18 States would be immediately excluded from the potential for State estimates and roughly 10 States have the potential for State estimation. Note: two States having no NHIS sample are not presented and several States have minimal sample size. Of course, for a true p > .10 the sample size standards would be less stringent for these coarse subdomains.

From tables 2 to 4 we see that State estimation appears limited to a handful of States when considering sub-State subdomains determined by race and ethnicity within the 18-64 year old population. For example, only three States exhibit the potential for estimating a 10 percent characteristic on the Black work force subdomain.

Horvitz-Thompson Estimators of State-Level Characteristics. Even though the NHIS was not designed to produce reliable State estimators, Horvitz-Thompson (henceforth referred to as H-T) estimators of totals can still be constructed. In the NHIS, two sample PSUs are drawn with probability proportional to population size from each NSR stratum. States with small populations are less likely to have sample representation. If a State has membership in a stratum, either 0, 1, or 2 sample PSUs in that stratum from the State will be selected. Now, the subdomain variable "State" is measured at the first stage of selection. If the State of interest is a characteristic of only one of the two drawn sample PSUs then the State characteristic is paired with a characteristic measured as zero when variances are considered. Thus the smaller States tend to have a large theoretical between PSU variance component for their estimates, and consequently, their estimates may be unreliable.

The standard H-T approach to the estimation of a State characteristic uses the same methodology as is used in NHIS estimation at the national level. The basic H-T estimator of total is an aggregate of observational measurements inflated by the reciprocal of probability of selection. The functional form for such at H-T estimator and its estimator of variance appears in Chapter IV of

Massey et al (1989). Means and proportions are the ratio of H-T totals and their variances can be estimated by Taylor linearization.

We wanted to measure the effect of possible large between PSU components of variation for State level estimates and the effect of small PSU sample sizes on variance estimation. Thus, we computed the theoretical variance of a linearized proportion and compared it to the 1987 NHIS estimated variance computed by the SUDAAN (1989) computer software, which uses the linearization approach to variance estimation. From a 1980 Census file of PSU aggregates, we constructed the stratified PSU sampling universe. This file contained no health variables, but only socio-economic-demographic variables.

We then computed the theoretical variance of the percentage of persons age 65+. This characteristic is roughly in the range 10-12 percent for most States and can also be estimated from the NHIS. While the theoretical between PSU variance can be computed from our 1980 universe file, the theoretical variance also contains a component for variation due to second stage sampling. This component cannot be directly computed from our file. Here, we studied the within second-stage variation within the sample NHIS PSUs and modeled the theoretical within variation using an average estimated dispersion.

Since there was a seven year time lag between the sample and universe files, the CV would be most stable measure of dispersion and thus the best for comparison. In Figure 2 the Theoretical CV versus the Estimated CV is plotted for all States. In this figure the State "0" is the United States. Here, the US theoretical CV was modeled to be 1.59 percent versus the estimated CV of 1.54 percent. The large States tend to have theoretical values close to estimated values, e.g., State 6, California, has theoretical CV 4.7 percent versus estimated CV 5.0 percent. The smaller States tend to grossly underestimate the CV, e.g., State 46, which has a theoretical CV of about 38 percent has an estimated CV of 3 percent. This discrepancy results from this State having only one sample PSU, and the linearization of proportions incorrectly reduces the between variance to 0. Using the standard of requiring no larger than a 10 percent theoretical CV, and an estimated CV close to the theoretical, we see that only about 10 States would achieve this.

Ratio Adjusted H-T Estimators. The national NHIS estimators are based upon ratio-adjusted H-T estimators of total. Two ratio adjustments are used: the first stage ratio-adjustment which attempts to reduce the between-PSU variance component of sampling variation among the NSR PSUs, and a poststratification ratio adjustment which ensures that the NHIS estimate of total for 60 age-race-sex classes agree with independent controls prepared by the U.S. Bureau of the Census. The forms of the ratio adjusted estimator appear in Chapter IV of Massey et al (1989).

We considered a first-stage ratio adjustment of NSR PSU's to their total Black and nonBlack status within a State. We used the 1980 Census universe to compute the theoretical variances of both a H-T estimator and its corresponding ratio-adjusted H-T estimator. Figures 3-5 show the results. Figure 3 shows that the first-stage ratio adjustment greatly reduces the variance for an estimator of State total. For an estimator of proportion the improvements are marginal. In Figure 4 we see little effect resulting by the adjustment to the variable age 65+. The most favorable variable to adjust should be the characteristic Black, and the improvements are presented in Figure 5. The first-stage ratio adjustment only reduces the CV of three additional States below the 10% level.

So in this most favorable situation only five States have CV below the 10 percent level. In conclusion, for means and proportions, little is to be gained by the inclusion of the first-stage ratio adjustment and thus we will not consider it further in this research.

We considered a poststratification adjustment within State by 8 sex-age groups with independent controls supplied by the Census Bureau. In the NHIS poststratification is important, since this adjustment addresses residual nonresponse and coverage problems. The Census Bureau cannot reliably project State totals within age and sex classes by race.

Still in order to keep the NHIS national race total controlled to the Census national race total we also tried a race modified adjustment. For this new adjustment we allocated the race totals to the 8 sex-age groups within State by national proportions to form thus 16 age-race-sex groups. This allocation will introduce some bias.

Since only about 10 States met our reliability standard for base weight estimation we only considered 9 larger States for the ratio adjustments. In Tables 5A and 5B, Base-Weight H-T estimators for total and mean annual doctor visits are computed along with their CV's. The change in the estimator and its CV due to the two types of State poststratification are also presented. First, estimates of total tend not to be reliable. This is basically due to the large between-PSU component of variance. The first stage adjustment, as we pointed out earlier, would reduce this component. Most State totals will increase with the poststratification because of coverage problems of the NHIS. For estimated base-weight means all the CV's meet our 10 percent CV standard. The ratio adjustments improve reliability more often than not. If a ratio adjustment is to be used, a race factor seems advantageous.

CONCLUSION

The NHIS has only limited potential for producing design based estimators at State-level. At the full State subdomain there are about 10 potential States, basically the 10 largest. At the State subdomain level, e.g., Black working age, there is less promise. In the next redesign of the NHIS, State estimation strategies will be a focal point.

ACKNOWLEDGEMENT

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REFERENCES

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Table 1. 1987 NHIS Sample Size by State* with the Coefficient of Variation (CV) for a 10 Percent Estimate Assuming DEFT = 1 or 2

NHIS Sample Size	State	CV (%) for 10% Estimate DEFT=1	DEFT=2
100	NH	26	51
100	AK	25	50
200	DE	21	42
200	HI	19	37
300	NV	17	34
300	NM	17	34
300	WY	17	34
300	DC	16	32
400	RI	15	30
400	VT	14	28
500	MS	13	26
500	ID	13	26
500	SD	13	26
500	ME	13	25
500	WV	12	25
900	SC	10	20
1,000	MT	9	19
1,100	UT	9	18
1,200	IA	8	17
1,300	OR	8	17
1,400	AR	8	16
1,500	CO	8	15
1,600	KS	7	15
1,600	CT	7	15
1,700	WA	7	14
1,800	KY	7	14
1,800	AZ	7	14
2,000	MD	7	13
2,100	MO	6	13
2,200	OK	6	13
2,400	IN	6	12
2,500	MN	6	12
2,500	AL	6	12
2,600	GA	6	12
2,700	LA	6	11
2,800	TN	6	11
3,300	VA	5	10
3,300	MA	5	10
3,400	NC	5	10
3,700	NJ	5	10
3,700	WI	5	10
4,400	MI	5	9
4,800	FL	4	9
5,700	IL	4	8
6,000	OH	4	8
6,600	PA	4	7
8,300	NY	3	7
9,100	TX	3	6
14,700	CA	2	5

*For States with 100 or more sample persons

Table 2. States Permitting Estimation of a 10 Percent Estimate of Persons Aged 18–64 Assuming a DEFT of 1 or 2, with a Coefficient Variation Less than 25 Percent

State	Coefficient of Variation (%) for 10 Percent Estimate of Persons Aged 18–64 Years *DEFT=1*	*DEFT=2*
NM	23	45
HI	22	44
NV	21	42
WY	21	42
DC	20	40
RI	19	38
MS	18	36
VT	17	35
SD	17	34
ID	17	34
WV	16	33
ME	16	32
SC	13	26
UT	13	25
MT	12	24
IA	11	22
OR	11	22
AR	10	21
KS	10	20
CO	10	19
CT	9	19
KY	9	19
WA	9	19
AZ	9	18
OK	8	17
MD	8	17
MO	8	17
AL	8	16
IN	8	16
MN	8	15
GA	8	15
LA	8	15
TN	7	14
MA	7	13
NC	7	13
VA	7	13
WI	6	13
NJ	6	12
MI	6	12
FL	6	11
IL	5	10
OH	5	10
PA	5	10
NY	4	8
TX	4	8
CA	3	6

Table 3. States Permitting Estimation of a 10 Percent Estimate of Blacks Aged 18–64 Years Assuming a DEFT of 1 or 2, with Coefficient of Variation Less than 25 Percent

State	Coefficient of Variation (%) for 10 Percent Estimate of Blacks Aged 18–64 years *DEFT=1*	*DEFT=2*
IN	23	46
DC	22	45
MO	20	40
SC	19	39
TN	18	35
MD	15	30
NJ	15	30
NC	15	29
PA	14	29
OH	14	29
AL	14	28
MI	14	27
GA	13	26
FL	13	26
VA	13	25
LA	12	25
IL	12	23
CA	10	20
TX	10	19
NY	9	18

Table 4. States Permitting Estimation of a 10 Estimate of Hispanics Aged 18–64 Assuming A DEFT of 1 or 2, with Coefficient of Variation Less than 25 Percent

State	Coefficient of Variation(%) for 10 Percent Estimate of Hispanics Aged 18–64 years *DEFT=1*	*DEFT=2*
NJ	23	46
IL	21	42
FL	16	32
NY	12	24
TX	10	19
CA	7	14

Figure 1: State Membership in Four NSR Strata

Figure 2: Theoretical CV (+) vs Estimated CV (*)
for Percentage Aged 65+ by State

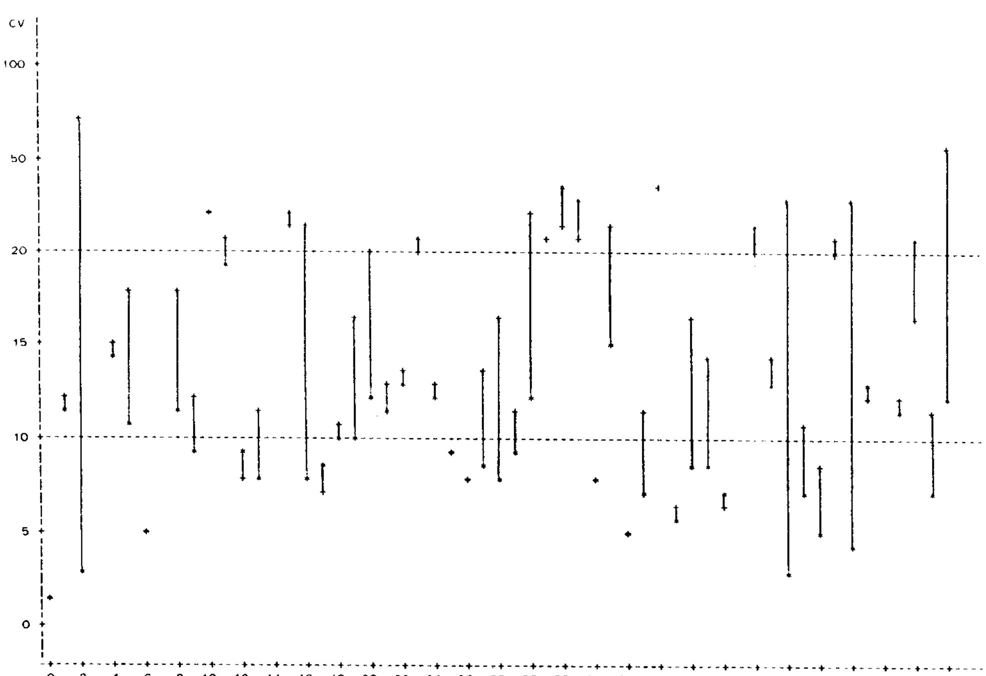

Figure 3: State CVs for Total Pop.

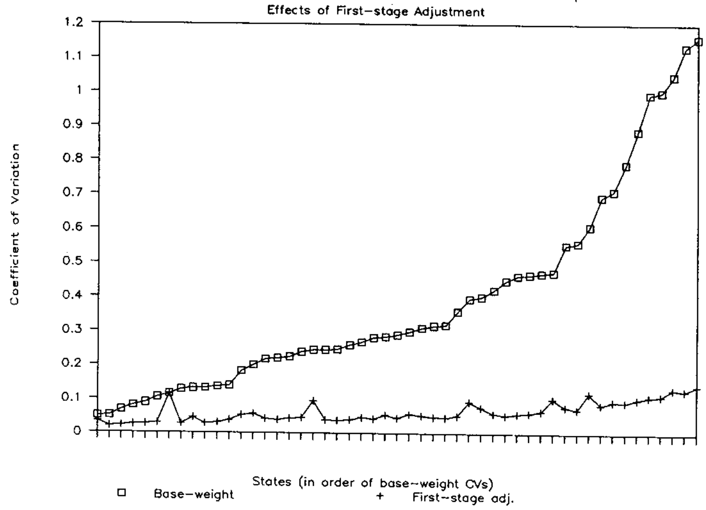

Figure 4: State CVs for Percent 65+

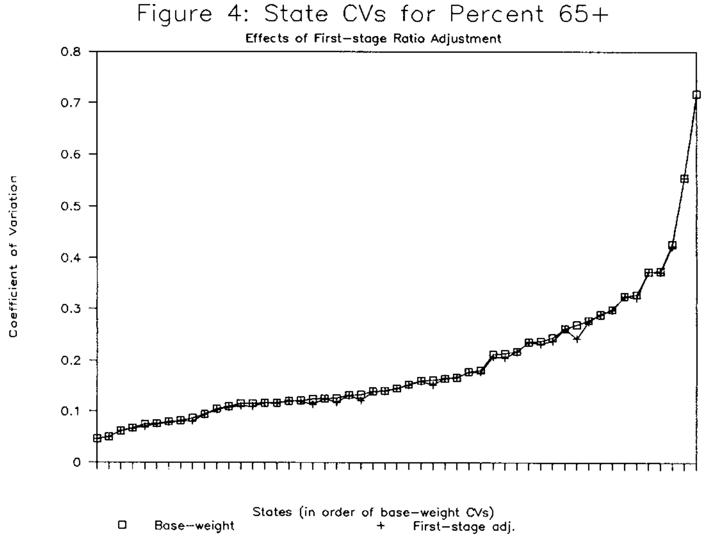

Figure 5: State CVs for Percent Black

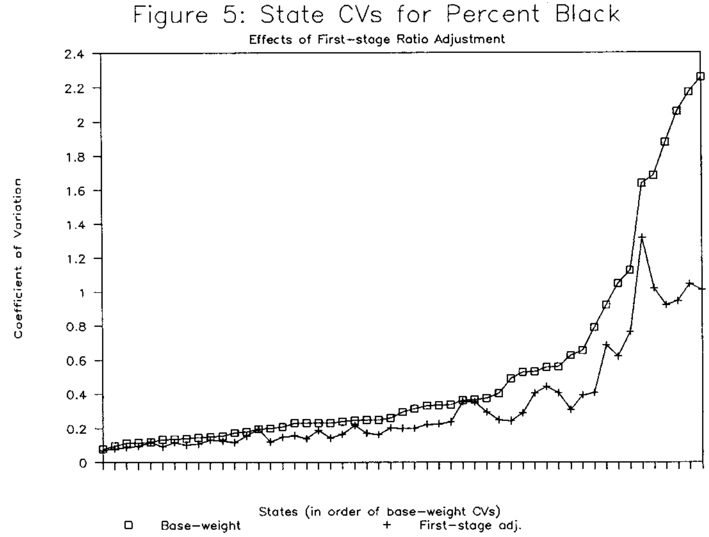

Table 5A. Annual Total for Doctor Visits
Effects of State Poststratification

STATE	Base Wt Total (1000's)	(1)	(2)	%CV Base Wt Total	(3)	(4)
CA	140,622	2.9	1.7	4.6	-0.4	-2.9
FL	52,938	29.4	29.7	13.0	-0.5	-2.3
IL	49,378	14.8	15.1	18.3	0.6	2.2
MI	54,608	15.0	13.9	10.8	-0.3	-0.7
NJ	30,327	8.7	9.0	13.0	-0.4	0.3
NY	84,131	15.0	16.0	7.5	-0.3	2.7
OH	65,506	-0.3	-0.4	14.6	-0.4	-3.1
PA	69,375	-6.4	-5.2	10.8	-2.1	-3.9
TX	73,098	0.7	1.3	11.1	-0.7	-0.4

Table 5B. Annual Mean for Doctor Visits
Effects of State Poststratification

STATE	Base Wt Mean	(1)	(2)	%CV Base Wt Mean	(3)	(4)
CA	5.39	-0.7	-1.9	3.2	-0.3	-0.4
FL	5.69	1.9	2.1	6.3	-4.3	-6.1
IL	4.94	0.6	0.9	6.1	-0.8	-0.4
MI	6.96	-0.6	-1.5	5.2	-4.0	-10.0
NJ	4.33	0.6	0.9	8.0	-0.5	-0.2
NY	5.56	-0.9	0.0	4.3	0.4	3.5
OH	6.17	-0.8	-0.9	5.1	-2.3	-5.0
PA	5.64	-2.1	-0.9	6.7	-2.0	-4.3
TX	4.50	-0.6	0.0	5.2	0.9	-0.1

(1) (age-sex ratio adjusted estimator / base-wt estimator - 1)*100%
(2) (age-sex-race ratio adjusted estimator / base-wt estimator - 1)*100%
(3) (age-sex ratio adjusted CV / base-wt CV - 1)*100%
(4) (age-sex-race ratio adjusted CV / base-wt CV - 1)*100%