Geographical Accuracy of Cell Phone Samples and the Effect on Telephone Survey Bias, Variance, and Cost

Benjamin Skalland, NORC at the University of Chicago
Meena Khare, National Center for Health Statistics

Abstract

Prior to sampling, geographic information can be derived from landline telephone numbers with great accuracy, allowing for state-specific landline surveys and effective geographic stratification for national surveys producing state-level estimates. However, the assignment of geographic information to cell-phone numbers is problematic because the cell-phone number is associated with the place the service for that cell-phone number was originally acquired, which is not necessarily the place where the person currently resides: a person could have acquired the service in a different state than the state of residence or could have moved to a different state since activation. Christian et al. (2009) estimate that less than 3 percent of landline households reside in a state that differs from the state associated with the landline telephone number, but about 12 percent of cell-phone-only adults reside in a state that differs from the state associated with the cell-phone number. In this paper, we present state-level estimates of the geographic inaccuracy of cell-phone samples for adults in cell-phone-only households from the National 2009 H1N1 Flu Survey. We then discuss the implications of cell-phone sample geographic inaccuracy on the bias and variance of dual-frame estimates, as well as on the cost of dual-frame surveys.

Keywords: Cell-Phone Sampling, Non-Coverage Bias.

1. Introduction

When conducting telephone surveys, researchers often wish to sample the target population living within a particular geographic area or to stratify the sample geographically. Each number in the telephone universe is assigned to a geographic location at the time of sampling based on the telephone number. The assignment of cell-phone numbers to geographic location can be based on the area code of the cell-phone number, the location of the wire center associated with the cell-phone number, or a combination of the area code and wire center location. (An area code can cover multiple wire centers, including wire centers in different states.) However, the cell-phone user may have purchased the cell-phone in a different location than where he or she currently resides or may have moved since the time of purchase. Therefore, the geographic area associated with the cell-phone number may differ from the geographic area of the user's residence, and the sampling of cell-phone users in a particular geographic area is thus subject to inaccuracy. The inaccurate geographic sampling of cell-phone users can lead to increased survey bias, variance, and costs.

In Section 2 of this paper we present estimates of the state-level inaccuracy of cell-phone samples of adults living in cell-phone-only households generated based on the area code of the phone number. In Section 3 we compare the characteristics of cell-phone-only adults whose sampling state differs from the state of residence to those whose sampling state matches the state of residence. In Section 4 we discuss the implications of inaccurate geographic cell-phone sampling on dual-frame telephone surveys, including surveys conducted in a single state and national surveys with state-level stratification. Section 5 summarizes and discusses the findings.

2. Estimates of Cell-Phone Sample State-Level Geographic Inaccuracy for Cell-Phone-Only Adults

The National 2009 H1N1 Flu Survey (NHFS) (CDC 2010a; CDC 2010b; NCHS 2012) was a large, state-stratified national random-digit-dial dual-frame telephone survey of U.S. adults conducted by the Centers for Disease Control and Prevention with NORC at the University of Chicago as the data collection agent. The purpose was to estimate national and state-level receipt of seasonal influenza and influenza A(H1N1)pdm09 (pH1N1) vaccination and related attitudes and behavior. Landline and cell telephone numbers were sampled independently within each state, with the sampling state for the landline and cell-phone samples assigned based on the area code of the telephone number. Data collection was conducted from October 2009 to June 2010. A total of 56,656 interviews were completed, of which 7,742 were completed with adults living in cell-phone-only households, resulting in an average of 150 cell-phone-only adult interviews completed in each state.

By comparing the sampling state to the respondent-reported (i.e., "true") state of residence among those with completed interviews, we estimate that 11.5 percent of adults living in cell-phone-only households reside in a state that differs from their sampling state based on the area code. This estimate is consistent with the 12 percent state-level inaccuracy estimate for cell-phone-only adults reported by Christian et al. (2009).

Table 1 presents estimates of state-level geographic sampling inaccuracy for cell-phone-only adults by sampling state. That is, of the cell-phone-only adults sampled from each state's cell-phone sampling frame, it shows the estimated percentage of cell-phone-only adults that reside in a different state. Because each state's cell-phone sampling frame contains some cell-phone-only adults that do not reside in that state, the state-level cell-phone sampling frames can be said to have "over-coverage." Estimates of this kind of sampling frame over-coverage vary considerably from state to state, from a low of 3.9 percent in Texas to a high of 51.7 percent in the District of Columbia. States with high geographic over-coverage rates tend to be small states in the Northeast: New Hampshire, Delaware, Rhode Island, and Vermont.

Table 2 shows the inaccuracy rate estimates by true state of residence; that is, of cell-phone-only adults residing in each state, it shows the estimated percentage that are not on that state's cell-phone sampling frame. These are estimates of each state sampling frame's "under-coverage" of cell-phone-only adults. The under-coverage estimates range from 4.1 percent in Nebraska to 30.6 percent in the District of Columbia.

3. Characteristics of Cell-Phone-Only Adults with Accurate and Inaccurate Sampling States

If the characteristics of cell-phone-only adults with inaccurate sampling states were the same as those with accurate sampling states, then the under-coverage of the state-level cell-phone sampling frames would not lead to biased estimates in state-specific dual-frame telephone surveys. However, cell-phone-only adults with inaccurate sampling states do in fact differ from those with accurate sampling states.

Table 3 presents the distributions of socio-demographic characteristics of cell-phone-only adults with accurate sampling states and those with inaccurate sampling states, as estimated from the 2009 NHFS. When compared with cell-phone-only adults with accurate sampling states, those with inaccurate sampling states are more likely to be young, non-Hispanic white only, and college graduates. They are also more likely to have high incomes, rent their homes, live in households that do not contain children, and live in metropolitan statistical areas (MSAs). All of these estimated differences were statistically significant at the α=0.05 level. These findings are consistent with those of Christian et al. (2009). These characteristics are correlates of mobility, which may be the underlying characteristic most related to state-level sampling inaccuracy.

Table 4 presents a comparison of selected estimates from the 2009 NHFS for cell-phone-only adults with accurate and inaccurate sampling states. (Because the survey was conducted throughout the 2009-2010 flu season, the flu vaccination rate estimates in Table 4 should not be considered as official estimates for the 2009-2010 flu season as a whole, but rather reflect whether the selected adult had received flu vaccinations for the 2009-2010 flu season prior to the interview.) We find that cell-phone-only adults with inaccurate sampling states were more likely to have received a seasonal flu vaccination and were less likely to report that they were very or somewhat concerned about the pH1N1 flu. These differences remain statistically significant at the α=0.1 level even after accounting for the demographic differences shown in Table 3. Differences in pH1N1 flu vaccination status and opinions about the effectiveness of the seasonal and pH1N1 flu vaccines were not statistically significant.

4. Implications for Dual-Frame Telephone Surveys

Cell-phone sample geographic inaccuracy has important implications for dual-frame telephone surveys, both for single-state surveys and for national surveys with state-level stratification.

Before we discuss these implications, we first note that cell-phone samples can be fielded using either a “take-all” design or a “screening” design. In a take-all design, interviews are attempted for adults in all identified cell-phone households; in a screening design, interviews are attempted only for adults in cell-phone households not accessible through the landline sampling frame – for example, cell-phone-only households. Because the 2009 NHFS used a screening design, the estimated levels of cell-phone sample geographic inaccuracy and differences between adults with accurate and inaccurate sampling states presented in Sections 2 and 3 apply to the population of adults living in cell-phone-only households and may not be generalizable to the population of all cell-phone adults that would be targeted under a take-all design. However, the issues arising due to cell-phone sample geographic inaccuracy that are discussed below will be present under either a screening or a take-all design, assuming that sampling inaccuracy and differences between accurately- and inaccurately-sampled adults exist under both designs.

Implications for Single-State Surveys

Many dual-frame telephone surveys aim to produce estimates for a single state, and the state-level geographic inaccuracy of cell-phone samples has potential cost and bias implications for such surveys. First, researchers must not assume that all of the cell-phone users identified through the state’s cell-phone sampling frame actually reside in that state; instead, researchers should collect the state of residence from respondents and screen-out the respondents who reside in a different state. This will lead to increased survey costs, as more cell-phone numbers will need to be sampled and dialed to complete the target number of cell-phone interviews for residents of the state. Second, researchers should consider the potential non-coverage bias of not interviewing residents of the state whose cell-phone number is on a different state's sampling frame and may wish to include a measure of mobility in weighting adjustments in order to correct for this potential non-coverage bias.

Implications for National Surveys with State-Level Stratification

National telephone surveys will not suffer from potential non-coverage bias due to cell-phone sample geographic inaccuracy – adults whose cell-phone number resides on a different state's sampling frame will still be covered, since sample will be drawn from all states. However, the geographic sampling inaccuracy will still have consequences for national surveys with state-level stratification.

First, as with single-state surveys, researchers should collect the state of residence from respondents so that the respondent can be assigned to the correct state of residence when producing state-level survey estimates.

Second, the geographic inaccuracy will make sample planning and management more complex, as the inaccuracy must be taken into account. For example, if a sample of cell-phone numbers is taken from the Virginia sampling frame, a portion of the completed interviews from those sampled cell-phone numbers will reside in states other than Virginia, and this should be taken into account when planning sample sizes for both Virginia and those other states. Similarly, a portion of the completed interviews for Virginia residents will come from other states' sampling frames, and this also needs to be taken into account when planning the sample sizes for Virginia and the sample sizes in those other states.

Finally, geographic inaccuracy of cell-phone samples will make state-level stratification less effective, which can lead to increased design effects and variances of survey estimates. Suppose a simple random sample were drawn from the cell-phone sampling frame in each state; if there were no geographic sampling inaccuracy, then all of the cell-phone respondents within each state would have the same base weight, equal to the inverse of the probability of selection of the phone number from the state's sampling frame. Yet with geographic sampling inaccuracy, a state's completed interviews would come not only from respondents with phone numbers sampled from that state's sampling frame, but also from some respondents with phone numbers sampled from other states' sampling frames. If the sampling rates from these sampling frames differ, then the base weights for the completed interviews for residents of a state will differ. The design effect (DEFF) is related to the coefficient of variation (CV) of the weights (Kish 1992):

$$DEFF \approx 1 + CV_{weights}^{2}$$

Therefore, differing base weights for the completed cell-phone interviews in a state increase the design effect, leading to larger variances for survey estimates.

Table 5 shows statistics related to the distribution of the base weights for cell-phone-only adults with a completed 2009 NHFS interview by the true state of residence, as well as the approximate DEFF based on these base weights. If there were no geographic sampling inaccuracy, there would be no variation in the base weights within a true state of residence, and the approximate DEFFs would all be equal to 1. However, due the sampling inaccuracy, the approximate DEFFs range from 1.02 in Maine and Nebraska to 2.60 in the District of Columbia. The median DEFF across the states is 1.22, indicating that in the median state, to produce estimates for the cell-phone-only population that are as precise as they would be if there had been no geographic sampling inaccuracy, 22 percent more cell-phone-only completed interviews would need to be obtained; this 22 percent increase is solely due to the geographic inaccuracy of the cell-phone sample.

5. Summary and Discussion

Unlike with landline telephone numbers, the geographic information associated with cell-phone numbers is often not accurate at the state level or at smaller geographic levels. We estimate that 11.5 percent of U.S. cell-phone-only adults reside in a state that differs from their sampling state based on the area code of the cell-phone number, and that this sampling inaccuracy varies considerably from state to state. The cell-phone sample geographic inaccuracy leads to higher survey costs and potential non-coverage bias for single-state cell-phone surveys, and can lead to increased design effects and sample planning/management complexity for national cell-phone surveys with state-level stratification.

While this paper has focused on state-level inaccuracy, the inaccuracies and consequences are much more severe at the sub-state level – Christian et al. (2009) estimate that the county-level sampling inaccuracy for cell-phone-only adults is 43 percent, and Montgomery et al. (2011) demonstrate great variation in sampling inaccuracy across a collection of county- and city-based sub-state sampling areas. It is also expected that the problem of geographic inaccuracy in cell-phone samples will worsen over time, as people continue to move from the location where they purchased their cell phone to a new location while still keeping the same cell-phone number.

References

Centers for Disease Control and Prevention (2010a) "Overview of the National 2009 H1N1 Flu Survey (NHFS)" http://www.cdc.gov/nchs/nis/h1n1_introduction.htm

Centers for Disease Control and Prevention (2010b) Interim Results: State-Specific Influenza A (H1N1) 2009 Monovalent Vaccination Coverage --- United States, October 2009—January 2010. *MMWR*, 59(12); 363-368

Christian, L., Dimock, M., and Keeter, S. (2009) "Accurately Locating Where Wireless Respondents Live Requires More Than a Phone Number." Pew Research Center for People and the Press. http://pewresearch.org/pubs/1278/cell-phones-geographic-sampling-problems

Kish, L. (1992) "Weighting for Unequal P_i." *Journal of Official Statistics*, vol. 8, pp. 183-200.

Montgomery, R., Tao, X., Wolter, K., Greby, S., and Kennedy, E. (2011). "Accuracy of Geographic Stratification in a Cell-Phone Survey," Paper presented at American Association for Public Opinion Research Conference, Phoenix, AZ, May 2011.

National Center for Health Statistics. (2012) *National 2009 H1N1 Flu Survey (NHFS) Public-Use Data File: Documentation, Code Book and Frequencies*. Hyattsville, MD. http://www.cdc.gov/nchs/nis/data_files_h1n1.htm

Table 1: Estimated Percentage of Adults Living in Cell-Phone-Only Households Whose Sampling State Differs from the True State of Residence, by Sampling State, National 2009 H1N1 Flu Survey

Sampling State	Estimated Percentage Inaccurate		Sampling State	Estimated Percentage Inaccurate	
U.S. National	11.5	(10.4, 12.8)	Missouri	12.3	(7.8, 19.0)
Alabama	11.1	(6.9, 17.4)	Montana	15.0	(9.2, 23.6)
Alaska	16.4	(9.5, 26.9)	Nebraska	15.9	(9.9, 24.5)
Arizona	12.2	(7.8, 18.5)	Nevada	10.8	(6.1, 18.4)
Arkansas	11.2	(5.7, 21.1)	New Hampshire	30.0	(18.9, 44.0)
California	14.4	(9.2, 21.8)	New Jersey	12.9	(7.8, 20.7)
Colorado	9.9	(5.9, 16.2)	New Mexico	10.0	(5.7, 17.0)
Connecticut	16.7	(10.9, 24.6)	New York	11.6	(7.5, 17.5)
Delaware	25.6	(17.5, 35.7)	North Carolina	9.1	(4.8, 16.4)
District of Columbia	51.7	(43.2, 60.0)	North Dakota	19.1	(12.6, 28.0)
Florida	9.8	(5.0, 18.4)	Ohio	13.3	(7.7, 22.2)
Georgia	12.6	(7.6, 20.3)	Oklahoma	5.3	(2.5, 11.1)
Hawaii	11.9	(6.7, 20.4)	Oregon	12.5	(7.6, 19.9)
Idaho	11.5	(6.4, 19.9)	Pennsylvania	12.0	(7.0, 20.0)
Illinois	13.0	(8.0, 20.3)	Rhode Island	24.8	(16.7, 35.1)
Indiana	11.2	(6.7, 18.3)	South Carolina	9.7	(4.4, 20.1)
Iowa	12.6	(7.4, 20.8)	South Dakota	6.6	(3.5, 12.1)
Kansas	18.5	(11.6, 28.2)	Tennessee	9.7	(5.5, 16.5)
Kentucky	8.1	(4.1, 15.3)	Texas	3.9	(1.9, 7.8)
Louisiana	7.1	(3.9, 12.8)	Utah	10.2	(4.2, 22.4)
Maine	14.4	(8.1, 24.3)	Vermont	21.6	(13.4, 32.8)
Maryland	16.4	(10.9, 23.9)	Virginia	16.5	(10.3, 25.5)
Massachusetts	15.3	(8.6, 25.9)	Washington	11.8	(6.8, 19.9)
Michigan	10.5	(6.0, 17.6)	West Virginia	13.6	(7.4, 23.7)
Minnesota	14.0	(7.8, 23.8)	Wisconsin	15.1	(8.6, 25.0)
Mississippi	10.8	(5.4, 20.4)	Wyoming	12.3	(7.9, 18.6)

Weighted estimates presented as point estimate (%) and 95% confidence interval. Sampling state was assigned based on the area code of the telephone number.

Table 2: Estimated Percentage of Adults Living in Cell-Phone-Only Households Whose Sampling State Differs from the True State of Residence, by True State of Residence, National 2009 H1N1 Flu Survey

True State of Residence	Estimated Percentage Inaccurate		True State of Residence	Estimated Percentage Inaccurate	
U.S. National	11.5	(10.4, 12.8)	Missouri	8.4	(4.8, 14.2)
Alabama	18.1	(9.2, 32.5)	Montana	8.3	(3.7, 17.4)
Alaska	22.0	(6.5, 53.3)	Nebraska	4.1	(1.2, 13.7)
Arizona	18.1	(9.4, 32.1)	Nevada	16.6	(5.3, 41.5)
Arkansas	10.3	(5.2, 19.4)	New Hampshire	9.7	(3.8, 22.8)
California	10.0	(7.2, 13.8)	New Jersey	11.5	(5.9, 21.3)
Colorado	17.1	(9.6, 28.6)	New Mexico	17.0	(7.2, 34.9)
Connecticut	20.0	(9.0, 39.0)	New York	12.2	(8.5, 17.2)
Delaware	13.8	(2.4, 50.7)	North Carolina	11.7	(7.5, 17.7)
District of Columbia	30.6	(16.7, 49.2)	North Dakota	9.2	(2.8, 26.1)
Florida	8.0	(4.5, 13.9)	Ohio	11.5	(6.8, 18.6)
Georgia	12.0	(7.5, 18.8)	Oklahoma	11.7	(3.8, 30.6)
Hawaii	7.0	(2.5, 18.2)	Oregon	15.5	(8.7, 26.2)
Idaho	8.7	(3.9, 18.2)	Pennsylvania	9.0	(4.8, 16.2)
Illinois	4.8	(3.0, 7.7)	Rhode Island	10.0	(2.8, 30.4)
Indiana	7.1	(3.8, 12.9)	South Carolina	11.1	(5.7, 20.7)
Iowa	20.7	(10.7, 36.1)	South Dakota	17.2	(6.8, 37.2)
Kansas	17.4	(9.8, 28.9)	Tennessee	11.3	(7.3, 17.1)
Kentucky	7.1	(3.3, 14.5)	Texas	8.9	(5.6, 13.9)
Louisiana	8.6	(4.3, 16.5)	Utah	6.3	(3.0, 12.8)
Maine	6.6	(3.2, 13.0)	Vermont	22.5	(9.6, 44.3)
Maryland	19.8	(11.1, 32.9)	Virginia	17.5	(12.6, 23.9)
Massachusetts	23.7	(15.6, 34.2)	Washington	11.9	(6.4, 21.1)
Michigan	18.2	(8.2, 35.5)	West Virginia	5.0	(1.5, 15.8)
Minnesota	7.1	(4.2, 11.9)	Wisconsin	11.7	(6.6, 19.8)
Mississippi	11.9	(6.3, 21.2)	Wyoming	9.4	(3.3, 24.4)

Weighted estimates presented as point estimate (%) and 95% confidence interval. Sampling state was assigned based on the area code of the telephone number.

Table 3: Estimated Socio-Demographic Distributions of Adults Living in Cell-Phone-Only Households by Cell-Phone Sampling State Geographical Accuracy, National 2009 H1N1 Flu Survey

Characteristic	Sampling State Matches True State of Residence	Sampling State Differs From True State of Residence
Gender		
Male	54.8±2.1	58.8±5.2
Female	45.2±2.1	41.2±5.2
Chi-square p-value: 0.168		
Age		
18-29 years	39.4±2.1	52.0±5.5
30-49 years	40.9±2.1	34.4±5.5
50+ years	19.7±1.6	13.6±3.7
Chi-square p-value: 0.000		
Race/Ethnicity		
Hispanic	24.2±2.0	14.4±4.3
Non-Hispanic Black only	15.1±1.6	11.5±4.5
Non-Hispanic White only	52.6±2.1	62.7±5.6
Non-Hispanic other/multiple races	8.1±1.1	11.5±3.2
Chi-square p-value: 0.000		

Characteristic	Sampling State Matches True State of Residence	Sampling State Differs From True State of Residence
Housing Tenure		
Home owned	43.9±2.1	27.1±4.8
Home rented	49.8±2.1	62.4±5.5
Home occupied by other arrangement	4.8±0.9	9.0±4.3
Unknown	1.5±0.5	1.5±1.4
Chi-square p-value: 0.000		
Number of Adults in the Household		
1	26.1±1.8	29.9±5.0
2	51.1±2.1	50.6±5.5
3+	22.8±1.9	19.5±4.9
Chi-square p-value: 0.267		
Number of Children in the Household		
0	60.4±2.1	74.1±5.4
1	17.1±1.6	13.4±3.8
2+	22.5±1.8	12.6±4.7
Chi-square p-value: 0.000		

Table 3 (continued): Estimated Socio-Demographic Distributions of Adults Living in Cell-Phone-Only Households by Cell-Phone Sampling State Geographical Accuracy, National 2009 H1N1 Flu Survey

Characteristic	Sampling State Matches True State of Residence	Sampling State Differs From True State of Residence
Education		
< 12 years	15.5±1.7	7.0±3.2
12 years	24.4±1.8	16.5±3.9
Some college	32.2±2.0	23.4±4.8
College graduate	27.9±1.8	53.1±5.5
Chi-square p-value: 0.000		
Marital Status		
Married	37.7±2.1	36.4±5.6
Never married	40.8±2.0	49.4±5.5
Widowed/divorced/separated	20.9±1.7	13.6±3.6
Unknown	0.7±0.5	0.7±0.9
Chi-square p-value: 0.008		
Income-to-Poverty Ratio		
< 100%	20.5±1.7	15.1±4.7
100-199%	17.2±1.6	15.3±3.8
200-399%	22.7±1.7	20.3±4.1
> 400%	25.7±1.8	36.1±5.3
Unknown	13.9±1.5	13.1±3.5
Chi-square p-value: 0.003		

Characteristic	Sampling State Matches True State of Residence	Sampling State Differs From True State of Residence
Poverty Status of Household		
Above poverty, income > $75K	18.4±1.6	25.3±5.1
Above poverty, income <= $75K	50.6±2.1	50.6±5.5
Below poverty	22.4±1.8	15.6±4.7
Unknown	8.6±1.2	8.5±3.0
Chi-square p-value: 0.010		
Metropolitan Statistical Area Status		
In MSA, principal city	42.1±2.1	46.4±5.4
In MSA, outside of principal city	43.0±2.0	44.4±5.5
Not in MSA	14.9±1.1	9.2±2.8
Chi-square p-value: 0.013		
Census Region of Residence		
Northeast	14.7±0.9	17.2±3.7
Midwest	20.1±0.9	18.1±4.6
South	43.3±1.3	39.9±5.3
West	21.8±1.1	24.8±4.8
Chi-square p-value: 0.297		

Weighted estimates presented as point estimate (%) ± 95% confidence interval halfwidth.

Table 4: Survey Estimates* for Adults Living in Cell-Phone-Only Households, by Cell-Phone Sampling State Geographical Accuracy, National 2009 H1N1 Flu Survey

Survey Estimate	Sampling State Matches True State of Residence	Sampling State Differs From True State of Residence
Received Seasonal Flu Vaccination in 2009-2010 Flu Season (Prior to Interview)		
No	72.5±1.8	67.9±5.1
Yes	27.1±1.8	32.0±5.1
Unknown	0.5±0.3	0.1±0.2
Chi-square p-value: 0.033		
Received H1N1 Flu Vaccination Since September 2009 (Prior to Interview)		
No	83.9±1.5	80.8±4.3
Yes	15.9±1.5	19.0±4.3
Unknown	0.3±0.2	0.2±0.3
Chi-square p-value: 0.258		
Opinion that Seasonal Flu Vaccine is Very or Somewhat Effective		
No	22.2±1.8	19.5±4.0
Yes	77.8±1.8	80.5±4.0
Chi-square p-value: 0.229		
Opinion that H1N1 Flu Vaccine is Very or Somewhat Effective		
No	28.3±1.9	26.0±4.6
Yes	71.7±1.9	74.0±4.6
Chi-square p-value: 0.374		
Very or Somewhat Concerned About H1N1 Flu		
No	46.0±2.1	60.4±5.2
Yes	53.7±2.1	39.4±5.2
Unknown	0.2±0.1	0.2±0.4
Chi-square p-value: 0.000		

Weighted estimates presented as point estimate (%) ± 95% confidence interval halfwidth.
* Estimates of influenza vaccination are incomplete (they include persons interviewed prior to the end of the period of vaccination) and used in this report for comparative purposes. Official estimates of influenza vaccination are available online at: CDC - Seasonal Influenza (Flu) - Reports on Flu Vaccination Coverage and Utilization.

Table 5: Distribution of Base Weights for Cell-Phone-Only Adults with Completed Interviews, by True State of Residence, National 2009 H1N1 Flu Survey

	Base Weight Distribution					
True State of Residence	**n**	**Mean**	**Median**	**Standard Deviation**	**CV**	**DEFF**
Alabama	174	2,992	2,820	1,076	0.36	1.13
Alaska	162	699	639	460	0.66	1.43
Arizona	214	3,401	3,303	2,000	0.59	1.35
Arkansas	186	2,417	2,244	1,132	0.47	1.22
California	272	15,886	21,616	8,704	0.55	1.30
Colorado	234	2,682	2,549	1,970	0.73	1.54
Connecticut	161	2,007	1,810	1,242	0.62	1.38
Delaware	161	607	561	600	0.99	1.98
District of Columbia	167	868	592	1,098	1.26	2.60
Florida	255	9,957	11,307	3,367	0.34	1.11
Georgia	229	5,770	6,024	1,820	0.32	1.10
Hawaii	177	868	788	735	0.85	1.72
Idaho	181	1,077	1,009	368	0.34	1.12
Illinois	234	7,322	7,933	2,032	0.28	1.08
Indiana	170	3,336	3,367	612	0.18	1.03
Iowa	172	2,564	2,322	1,695	0.66	1.44
Kansas	175	2,290	2,044	1,614	0.71	1.50
Kentucky	167	2,329	2,250	495	0.21	1.05
Louisiana	180	1,980	1,927	528	0.27	1.07
Maine	149	713	720	87	0.12	1.02
Maryland	243	3,040	3,833	2,138	0.70	1.49
Massachusetts	207	2,895	3,334	1,554	0.54	1.29
Michigan	183	6,544	6,729	1,189	0.18	1.03
Minnesota	196	3,078	3,432	991	0.32	1.10
Mississippi	188	2,017	1,879	666	0.33	1.11
Missouri	184	4,126	4,384	885	0.21	1.05

Table 5 (continued): Distribution of Base Weights for Cell-Phone-Only Adults with Completed Interviews, by True State of Residence, National 2009 H1N1 Flu Survey

	Base Weight Distribution					
True State of Residence	**n**	**Mean**	**Median**	**Standard Deviation**	**CV**	**DEFF**
Montana	153	838	772	505	0.60	1.36
Nebraska	159	1,509	1,510	231	0.15	1.02
Nevada	187	2,031	1,768	2,164	1.07	2.13
New Hampshire	123	674	603	407	0.60	1.36
New Jersey	187	2,609	2,433	1,157	0.44	1.20
New Mexico	230	1,453	1,239	1,728	1.19	2.42
New York	220	7,959	9,416	3,286	0.41	1.17
North Carolina	240	4,537	4,657	1,660	0.37	1.13
North Dakota	127	565	521	364	0.65	1.42
Ohio	202	5,314	5,719	2,016	0.38	1.14
Oklahoma	176	2,362	2,224	1,560	0.66	1.44
Oregon	214	3,350	3,135	2,278	0.68	1.46
Pennsylvania	183	7,049	8,174	2,600	0.37	1.14
Rhode Island	136	874	803	414	0.47	1.22
South Carolina	178	2,349	2,189	1,033	0.44	1.19
South Dakota	150	728	671	426	0.59	1.34
Tennessee	191	4,252	4,429	872	0.21	1.04
Texas	299	11,663	13,730	4,517	0.39	1.15
Utah	218	2,115	2,143	508	0.24	1.06
Vermont	137	388	321	414	1.07	2.14
Virginia	270	3,656	4,688	2,246	0.61	1.38
Washington	220	4,254	4,642	1,817	0.43	1.18
West Virginia	148	977	918	513	0.53	1.28
Wisconsin	176	4,057	3,925	1,474	0.36	1.13
Wyoming	172	433	405	216	0.50	1.25

CV is the coefficient of variation. DEFF is the design effect introduced due to the geographic sampling inaccuracy, and is approximated as $1+CV^2$.