Cell Phone Coverage in an ABS Multi-Mode Design

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Abstract
By the end of 2011, 32.3 percent of adults lived in cell phone only (CPO) households. Multi-mode address-based sampling (ABS) has been assumed to cover CPO households that are missed in traditional landline random-digit dialing (RDD) designs. The ABS frame covers nearly all addresses, and data collected via mail allows us to capture data from these individuals. No literature, however, has yet to publish statistics on how well multi-mode ABS designs capture the CPO households in a hard-to-reach population. We attempt to answer this question using data collected in Phase 4 of the Racial and Ethnic Approaches to Community Health across the U.S. (REACH U.S.) Risk Factor Survey. Our results suggest that ABS designs with a mail component cover CPO households and that the inclusion of these CPO households significantly changes some health estimates.

Key Words: Cell phone only, multi-mode address-based sampling

1. Introduction

By the end of 2011, 32.3 percent of adults lived in cell phone only (CPO) households (Blumberg & Luke, 2012). This growing percentage of CPO households increased the under-coverage of landline random-digit-dialing (RDD) telephone surveys. This under-coverage could introduce bias into survey estimates, because adults living in CPO households differ significantly from adults living in households with a landline in terms of demographics (Blumberg & Luke, 2012) and some health statistics (Link et al., 2007). Furthermore, some hard-to-reach populations, such as Hispanics and adults living in poverty, are more likely to live in CPO households (Blumberg & Luke, 2012). Previous surveys on minority racial/ethnic groups have also shown significant differences in demographics between respondents reached by cell phone and those reached by landline (Dutwin et al., 2010).

Address-based sampling (ABS) designs have been used as an alternative to landline RDD designs. Previous studies have shown that ABS covers CPO households in general population surveys (Link et al., 2008). No literature, however, has yet to publish statistics on how well ABS captures CPO households in a hard-to-reach population survey. In this paper, we tackle this issue by using base-weighted preliminary data collected in Phase 4 of the Racial and Ethnic Approaches to Community Health across the U.S. (REACH U.S.) Risk Factor Survey, a community-level survey focused on minority groups. We attempt to answer the following research questions: (1) What is the observed distribution of phone ownership among these rare populations? (2) Is the observed proportion of CPO adults in this rare population survey similar to the proportion of CPO adults in the general population? (3) Does the inclusion of CPO adults in this study affect the estimates of key health statistics?

2. Data and Method

The REACH U.S. Risk Factor Survey is sponsored by the Centers for Disease Control and Prevention as part of an effort to understand and eliminate health disparities among racial and ethnic minority populations. It is conducted in 28 communities of various sizes across the nation. A community could be as large as a state or as small as several Census tracts. The priority population also varies by community and includes one or more of the following racial/ethnic groups: Hispanic, African American, Haitian, Asian/Pacific Islander, and Native American. REACH U.S. geographies tend to include areas with higher immigrant populations, lower income individuals, more non-English speakers, and/or lower literacy rates than the national average. These demographics, in addition to the race/ethnicity focus, make a large proportion of the survey population hard-to-reach.

A multi-mode ABS design was chosen for the REACH U.S. survey as it offers the potential for gains in coverage and response. The design begins with an ABS frame using the U.S. Postal Service Delivery Sequence File and attempts to match all addresses to telephone numbers. Where the address can be matched by a vendor to a telephone number, the household is typically attempted first by telephone. Where a telephone number cannot be matched to the address, the household is attempted by mail. Households that cannot be reached by telephone are followed up by mail. In select communities, in-person interviews were also conducted for a subsample of households. This paper focuses on interviews collected via telephone and mail. Two of the 28 communities are excluded from the analysis, because they do not have a mail component and rely heavily on in-person interviews.

In REACH U.S. Phase 4, each respondent is asked one or more questions to determine whether anyone in their household has a landline telephone, a cell telephone, both, or neither. Since Phase 4 data collection for REACH U.S. is ongoing as of this writing, we use preliminary data in this paper. The data is base-weighted (adjusted for selection probabilities only) to control for sample design differences among the communities.

The analyses conducted are threefold. Each analysis answers one of the three research questions. First, we provide descriptive statistics on the distribution of adult telephone ownership as observed in REACH U.S. Data is available overall and by mode of completion.

Second, we compare the base-weighted REACH U.S. data to weighted phone ownership data collected by the National Health Interview Survey (NHIS). The NHIS provides telephone coverage estimates of the general population using an area-probability, in-person design. REACH U.S. geographies were matched as closely as possible to NHIS geographies—state or sub-state areas where NHIS reported state-level CPO estimates (Blumberg et al., 2011). In some areas, this involved collapsing neighboring REACH U.S. communities into one community. NHIS state-level estimates were not publically available by racial/ethnic subgroups. Therefore, we used NHIS region-level estimates for racial/ethnic subgroups to adjust the NHIS state-level estimates for all races/ethnicities. The adjustment was done by calculating the ratios of the NHIS CPO estimates for

REACH U.S. racial/ethnic groups to the NHIS CPO estimate for all races/ethnicities by region and then multiplying the NHIS state-level estimates by these ratios.

Finally, we analyze how key health statistics might change if the CPO adults were excluded from the sample. Of particular interest are estimates of general health, smoking, cholesterol, and diabetes prevalence. We further simulate whether post-stratifying the weights is sufficient to correct for the unknown change in health statistics due to the exclusion of CPO adults. We do this by running logistic regressions of each health variable on CPO status while controlling for some common demographic variables used in post-stratification—age, sex, race, employment status, and education.

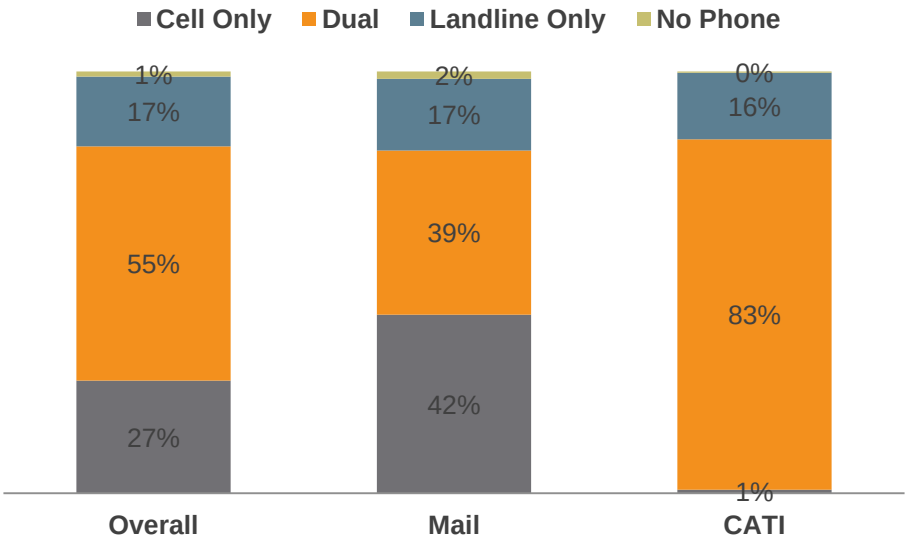
3. Results

3.1 Distribution of Phone Ownership in REACH U.S.

Overall, we observed 27 percent CPO adults, 17 percent landline-only adults, 55 percent cell and landline (dual) adults, and 1 percent no phone adults in REACH U.S (Figure 1). This provides evidence that in a hard-to-reach population survey, multi-mode ABS designs that use a telephone and mail component cover adults living in CPO households in addition to dual-use households, landline-only households, and no phone households.

REACH U.S. interviews conducted via telephone mostly cover adults living in households with a landline. This is as expected because addresses fielded via telephone are mainly those that were matched to a telephone number, and vendor address-to-telephone services are currently limited to matching to landline telephone numbers. The lack of CPO coverage in the telephone mode is more than compensated for by interviews collected via mail – 42 percent of adults completing via mail live in CPO households.

Figure 1: Distribution of Phone Ownership in REACH U.S.: Overall and By Mode

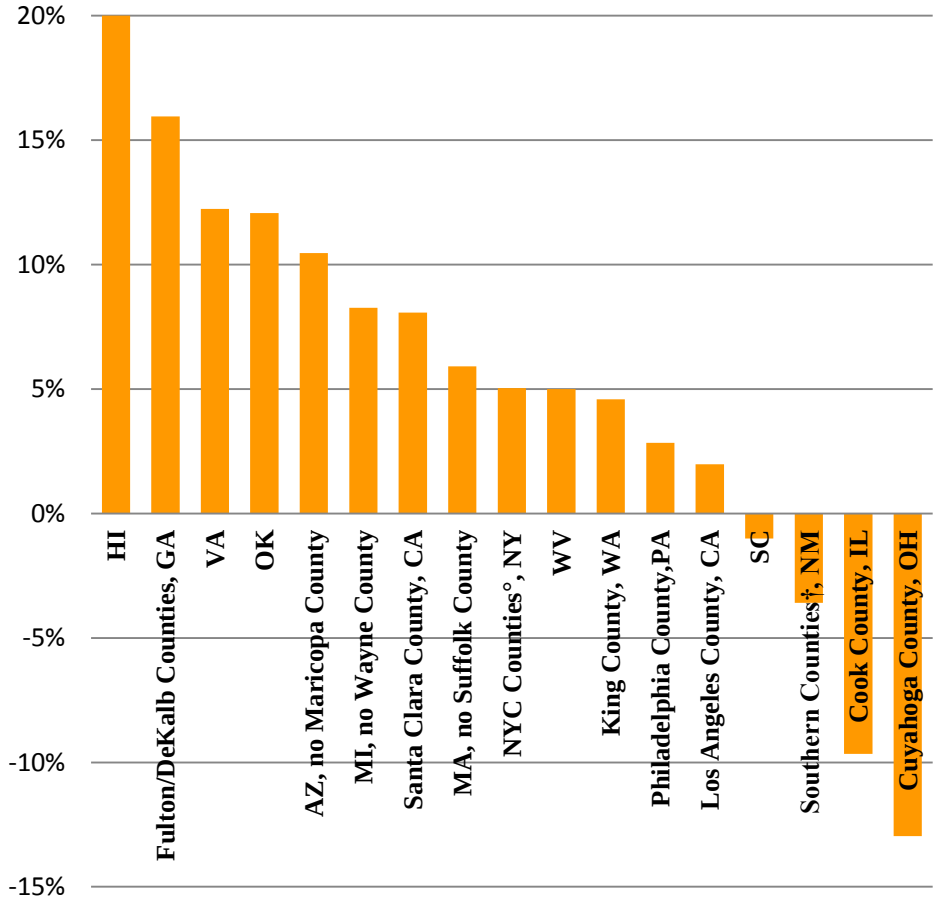


3.2 Observed vs. Population: Proportion of CPO adults

When comparing the observed proportion of adults living in CPO households in REACH U.S. with the proportion in the population (NHIS), we found that seven of the 17

collapsed community areas were within 5 percentage points of the NHIS adjusted estimate (Figure 2). REACH U.S. underestimated the CPO population in three community areas and overestimated it in the remaining eight community areas.

Figure 2: REACH U.S. minus NHIS Adjusted Percent Adults in CPO Households by Collapsed Community Areas



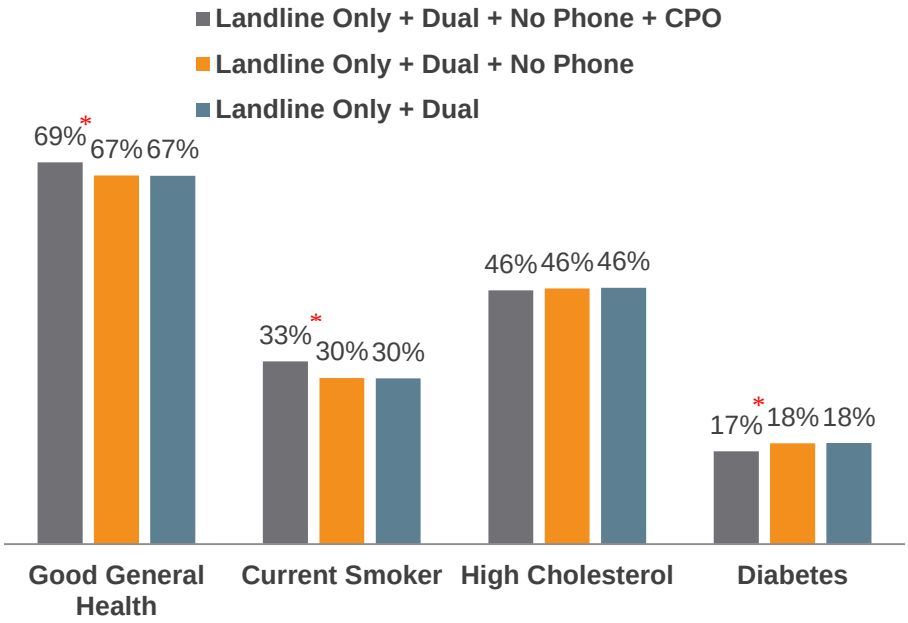
† Includes Chaves, Lea, Eddy, Lincoln, Socorro, Catron, Sierra, Curry, Roosevelt, De Baca, Dona Ana, Otero, Luna, Grant, and Hidalgo.
° Includes Queens, Kings, Richmond, New York, and Bronx.

We hesitate, however, in making conclusions based on this analysis. We are unable to run significance testing, because NHIS did not provide sample sizes for their state-level estimates. Furthermore, this comparison is limited by geographic and demographic differences between REACH U.S. and NHIS. To create a more robust comparison to NHIS, we could post-stratify REACH U.S. by demographic variables. However, NHIS state-level demographic estimates are not publically available; we would need to use the NHIS region-level demographics in post-stratification. Another possibility would be to go to a NHIS data center to download data for REACH U.S. geographies and races/ethnicities. However, there is concern that the resulting sample sizes would be too small (or, non-existent) to produce stable estimates for CPO adults using small-area estimation.

3.3 Inclusion of CPO Adults Influences Health Estimates

Figure 3 shows the changes in select health estimates when we exclude adults living in CPO households from the completed interviews and when we further exclude adults living in no-phone households. The inclusion of adults living in CPO households significantly increased estimates of individuals in good general health and the proportion of current smokers and lowered the estimated proportion of diabetics when compared to estimates excluding interviews of CPO adults. The inclusion of adults in no-phone households did not have a significant effect on the health estimates, likely because of their small proportion.

Figure 3: Health Estimates by Phone Ownership



*Difference between health estimates for "landline only + dual + no phone + CPO" and for "landline only + dual + no phone" is statistically significant at α=0.05 level.

Excluding CPO adults would significantly change health estimates when working with base-weighted data. Furthermore, post-stratified weights are insufficient to correct for this change. Table 1 shows the results of four logistic regression models with health variables as dependent variables and CPO status as the independent variable, while controlling for some common demographic variables used in post-stratification—age, sex, race, employment status, and education level. We found that CPO status is significant for all four health estimates—good general health, current smoker, high cholesterol, and diabetes. In other words, the demographic variables are insufficient at capturing all the differences between CPO adults and landline adults. Post-stratification based only on these variables is, therefore, insufficient to correct for the unknown coverage error due to non-coverage of CPO adults.

Table 1: Results of Logistic Regressions of Health Variables on CPO status When Controlling for Demographic Variables

	Good General Health		**Current Smoker**		**High Cholesterol**		**Diabetes**	
	Odds Ratio	*95% Confidence Limits*	*Odds Ratio*	*95% Confidence Limits*	*Odds Ratio*	*95% Confidence Limits*	*Odds Ratio*	*95% Confidence Limits*
CPO vs Landline	0.918**	(0.905,0.930)	0.939**	(0.922,0.956)	1.222**	(1.204,1.240)	1.072**	(1.053,1.092)
Age	1.023**	(1.023,1.024)	1.033**	(1.032,1.033)	1.039**	(1.039,1.040)	0.955**	(0.954,0.956)
Male vs Female	0.901**	(0.890,0.912)	0.848**	(0.834,0.863)	1.190**	(1.175,1.205)	0.850**	(0.837,0.863)
Hispanic[α]	1.131**	(1.101,1.161)	3.489**	(3.379,3.602)	0.712**	(0.692,0.732)	0.729**	(0.706,0.753)
Black[α]	0.655**	(0.636,0.675)	1.780**	(1.719,1.843)	0.590**	(0.573,0.609)	0.846**	(0.818,0.876)
Asian[α]	1.195**	(1.164,1.226)	2.781**	(2.693,2.872)	0.760**	(0.739,0.781)	1.414**	(1.369,1.460)
Other Race[α]	1.101**	(1.070,1.133)	1.233**	(1.193,1.275)	0.864**	(0.838,0.891)	0.608**	(0.588,0.630)
Employed for Wage[β]	0.140**	(0.137,0.143)	1.432*	(1.391,1.475)	0.616**	(0.602,0.630)	2.846**	(2.782,2.912)
Self-Employed[β]	0.096**	(0.093,0.099)	1.510**	(1.451,1.572)	0.683**	(0.663,0.704)	2.958**	(2.857,3.063)
Out of Work for More than 1 Year[β]	0.291**	(0.283,0.299)	1.088**	(1.047,1.131)	0.733**	(0.709,0.757)	1.969**	(1.908,2.032)
Out of Work for Less than 1 Year[β]	0.149**	(0.143,0.154)	1.039**	(0.990,1.091)	0.475**	(0.456,0.494)	3.845**	(3.665,4.035)
Homemaker[β]	0.214**	(0.208,0.220)	2.023**	(1.935,2.116)	0.634	(0.616,0.653)	1.909**	(1.851,1.968)
Student[β]	0.135**	(0.130,0.141)	1.897**	(1.797,2.002)	0.563**	(0.538,0.589)	2.805**	(2.643,2.977)
Retired[β]	0.149**	(0.145,0.152)	1.613**	(1.557,1.672)	0.485**	(0.473,0.498)	2.304	(2.248,2.361)
Kindergarten or Less[γ]	10.124**	(9.407,10.895)	0.665**	(0.590,0.750)	2.152**	(1.975,2.344)	0.702**	(0.654,0.753)
Elementary School[γ]	5.983**	(5.858,6.111)	0.287**	(0.278,0.297)	1.260**	(1.232,1.288)	0.674**	(0.657,0.691)
Some High School[γ]	3.288**	(3.220,3.358)	0.413**	(0.399,0.426)	1.422**	(1.391,1.454)	0.761*	(0.741,0.781)
High School Graduate[γ]	2.775**	(2.728,2.822)	0.347**	(0.339,0.356)	1.424**	(1.400,1.449)	0.726**	(0.711,0.741)
Some College or Technical School[γ]	1.833**	(1.802,1.864)	0.534**	(0.522,0.547)	1.212**	(1.193,1.231)	0.875**	(0.857,0.894)

*Significant at α=0.05 level **Significant at α=0.01 level
[α]Comparison group is "multi-race"
[β]Comparison group is "unable to work"
[γ]Comparison group is "college graduate"

4. Conclusion

The REACH U.S. data provides us with evidence that multi-mode ABS using mail and phone covers CPO households in addition to households with landline or no phone in a hard-to-reach population study. This coverage of CPO households is important because their inclusion significantly affects some health estimates. Without the CPO households, we would introduce potential coverage bias into some health statistics. This is consistent with other work for general population surveys (Blumberg & Luke, 2007).

Due to the lack of an appropriate external source for comparison, we were unable to assess how accurately multi-mode ABS captures the distribution of phone status in the hard-to-reach population. For future analyses, we would resolve this issue by finding better sources of CPO estimates for small areas and by races/ethnicities. We believe this is feasible, since more and more surveys are interested in and interviewing the CPO population.

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