Conducting a Telephone Survey Using an ABS Sample: A Case Study of the California Health Interview Survey

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Abstract

Geographically targeting samples in small areas is difficult in telephone surveys with a cell phone component. There have been several solutions practitioners have used to increase the efficiency of targeting telephone surveys to small areas. One is the use of address-based sampling (ABS), which allows a very precise targeting of small geographic areas. Because addresses are sampled, this design is best suited for mail surveys. However, in some surveys, the flow of questions and skip patterns in the instruments are too complex to be completed on paper. As a result, there has been interest in using ABS samples as a way to recruit respondents for telephone surveys. To do so, a telephone number must be obtained for the sampled addresses. A telephone number can either be matched to the sampled address or requested via a letter mailed to the sample addresses.

The California Health Interview Survey (CHIS) is a dual-frame random digit dialing (RDD) telephone survey of the population of California. In 2013-2014, an ABS sample was used to supplement the RDD sample in one rural county in which geographic targeting for the cell phone sample required a large screening effort. We describe the CHIS experience with the use of an ABS sample to recruit respondents for a telephone survey targeting a small geographic area. Methods to obtain telephone numbers; data collection outcomes, including response rates, disposition codes, and accuracy of the telephone matching; and estimates of health and demographics are compared between the RDD and ABS samples.

Key words: Telephone survey, address-based sampling, cell phone sample, small area

1. Introduction

Often, surveys are tasked with producing estimates for specific geographic areas. Traditionally, this has been very relatively straightforward to accomplish with random digit dialing (RDD) landline surveys. Landline telephone numbers are assigned based on the geographic location of the household and thus provide a fairly precise method for pinpointing geographic locations. The inclusion of cell phones to RDD methodology presents a challenge for targeting of samples to small geographic areas. Unlike landline telephone numbers, cell phone numbers are assigned to the geographic location of the rate center closest to the place where the telephone number is activated or purchased (Marketing Systems Group). As a result, the geographic location mapped to a cell phone number does not necessarily correspond to the location of household of the telephone user; the location assigned to the cell phone number can be very different from the cell phone user's household location. Christian, Dimock, and Keeter (2009) estimated the agreements between the assigned telephone number and the respondent's zip code. While both landline and cell are fairly accurate at the state level, with 97 percent agreement for landline and 90 percent agreement for cell, the percentage agreement decreases for smaller areas. At the county level, while landline agreement remains high at 92 percent, the cell phone agreement drops to 59 percent. This disagreement or misclassification error has implications for the sample allocation, survey cost, and precision of estimates for these areas. As telephone surveys allocate more of the sample to cell phones, geographic targeting becomes challenging for both dual-frame RDD (i.e., both landline and cell telephone samples) and cell-only RDD designs.

2. The California Health Interview Survey (CHIS)

To explore the differences between a regular telephone survey and an ABS telephone survey approach, we examine the 2013-2014 California Health Interview Survey (CHIS). CHIS is an RDD dual-frame telephone survey of California's population. CHIS is the largest health survey ever conducted in any state and one of the largest health surveys in the United States. It is a collaborative project of the UCLA Center for Health Policy Research, the California Department of Health Services, and the Public Health Institute. The funding for CHIS includes sources such as the state and federal government agencies and private foundations, among others. Westat is the data collection contractor and develops the CHIS weights.

CHIS collects extensive information on public health, health status, prevalence of chronic conditions, health-related behaviors, health insurance coverage, and access to health care services. Data from CHIS support the production of estimates for the state and for multiple smaller geographic areas represented by counties and groups of counties in California.

CHIS 2013-2014 was a dual-frame RDD telephone survey. By design, 20 percent of the sample was allocated to the cell phone frame and the remaining 80 percent to the landline frame. CHIS used an overlapping design; that is, all sampled phone numbers were eligible regardless of cell phone usage and the frame from which they were sampled. The RDD sample methodology implemented in CHIS met the geographic requirements, allowing the production of estimates for the state overall and for specific counties and groups of counties. Adults, parents or guardians of children, and adolescents within California households are eligible for sampling. Data were collected using a computer-assisted telephone interviewing (CATI) instrument, reflecting the different types of respondents and questionnaire complexity. The data were collected over a 2-year period. A total of 38,000 adult interviews were completed in CHIS 2013-2014. The analysis presented here is based solely on the adult interviews.

3. Supplemental Sonoma Sample

3.1 Background

In the 2013-2014 cycle, additional survey questions were added to the regular CHIS sample for Sonoma County, a rural county in California with a separate target of 500 of completed adult interviews. To obtain more precise estimates to support the additional questions, a supplemental sample with the same size was needed in addition to the sample for the main CHIS. Drawing a supplemental sample utilizing the same dual-frame design used in the main CHIS but restricting the frames to include those telephone numbers located in the county was considered both inefficient design and would lead to biased estimates. This conclusion was based on the observed sample distribution of the main CHIS sample. In the main CHIS design, 3 percent of landline respondents sampled in Sonoma reported to live in a different county. This result is similar to the findings by Christian et al. (2009). In contrast, the cell phone sample had both overcoverage and undercoverage issues, as defined by Skalland and Khare (2013). Overcoverage refers to the telephone numbers on the sampling frame for a given geographic area that correspond to persons who reside elsewhere. For the main CHIS sample, close to 24 percent of cell phone respondents with telephone numbers sampled in Sonoma County reported that they lived outside the county. On the other hand, undercoverage refers to telephone numbers for persons residing in a specific geographic area that do not appear on the sampling frame for that area. For Sonoma County, the results from the main CHIS design indicate that the undercoverage rate for Sonoma County was 24 percent (coincidentally the same as the overcoverage rate). That is, 24 percent of cell phone users residing in Sonoma County do not appear on the Sonoma County cell phone frame, but have telephone numbers that correspond to other geographic areas instead.

Because of the overcoverage, drawing a sample from the Sonoma County cell phone frame to select a sample of Sonoma County residents is inefficient because almost a quarter of the frame is ineligible for the survey. At the same time, estimates from this sample are likely to incur a large bias because of undercoverage, since 24 percent of eligible residents are excluded from the frame.

Christian et al. (2009) report differences between respondents whose cell phone number accurately reflects their geographic area and those who do not for demographic variables such gender, age, race, and education indicators. As a result, it is likely that a sample based on a Sonoma County cell phone frame may yield similarly biased estimates.

Overcoverage and undercoverage are not major issues for the main CHIS sample design because of how the sample size targets at the smaller areas are met and their estimates are computed. Overcoverage in one county benefits undercoverage in adjacent counties. Efforts are made to estimate overcoverage and undercoverage rates within each when selecting the overall sample to capitalize on the geographic misclassification among strata. However, the differential sampling rate of the final sample in counties that benefited from overcoverage from adjacent counties produces a larger design effect that reduces the efficiency of the estimates. Overcoverage and undercoverage also affect the sample at the state level but to a much lesser extent. That is, there is overcoverage which corresponds to the persons with cell phone with a California area code number who reside outside of California and undercoverage for those who have a cell phone number with area codes outside California but reside in California. The latter cannot be evaluated using the CHIS data.

Skalland and Khare (2013) suggest a way for correcting for the undercoverage bias of cell phone frames by including neighboring geographic areas (that is, including the counties adjacent to Sonoma County in the sampling frame for Sonoma). However, as Skalland and Khare point out, this introduces data collection inefficiencies (i.e., larger costs) into the design as it increases the amount of overcoverage on the frame. Most telephone numbers on the frames for the adjacent counties are not those of residents of Sonoma County. The increased costs could be reduced by oversampling areas more likely to a reach a Sonoma County resident and undersampling those areas less likely to include those. This approach, known as disproportionate sample allocation, is described by Flores Cervantes and Kalton (2007) for landline surveys. Although this approach solves the problem of undercoverage, this differential sampling increases the design effect due to the variability of the sample weights and results in less precise estimates.

Link, Battaglia, Frankel, Osborn, and Mokdad (2008) present a compelling argument for utilizing address-based sampling (ABS) methodologies in place of telephone surveys for general population surveys, especially regarding health surveys. They show that the ABS design yields a higher response rate with a significant cost savings over the RDD design. An ABS design allows for very precise geographic targeting as the sample unit is an address, which can be geocoded into a geographic location as small as a census block. As such a design is cost efficient and can produce unbiased estimates, it was selected for supplementing the CHIS sample for Sonoma County.

An important point to highlight is the difference in data collection modes between the Link et al. (2008) study and the CHIS Sonoma ABS supplement. Since the sampled unit is an address in an ABS design and the first contact with respondents is through mail, a paper survey was the natural choice for the survey instrument in their study. In contrast, due the length and complexity of the CHIS survey instrument, a CATI approach is better suited than a mailed paper questionnaire. Link et al. did not explore methodology for utilizing an ABS design to conduct a telephone interview.

The use of the ABS frame to supplement a telephone sample was explored by Jans et al. (2013). They conducted a small pilot study on the feasibility of conducting a telephone survey using an ABS sampling frame; their study was based on two small neighborhoods in Los Angeles and Merced counties. The CHIS 2013-2014 sample design for Sonoma County builds on those results.

3.2 Methodology

The Sonoma County sample consisted of two samples of approximately equal size: the main CHIS sample and the supplemental sample. The main CHIS sample was drawn using a dual-frame RDD methodology from both landline and cell phone frames. This analysis includes only adult respondents who were sampled in the Sonoma stratum and reported residing in Sonoma County (i.e., it excludes cases sampled from surrounding areas). In general, landline cases and cases from other geographic strata were sampled at different rates than those cases sampled in the Sonoma strata.

The data collection contact protocol for the main CHIS sample is shown in Figure 1. In the figure, percentages of cases are provided at every step for both the landline and cell phone samples, respectively (landline percentages in blue on the left and cell phone percentages in red on the right). For the most part, the contact protocol was the same for landline and cell phone samples. Once the sample is selected, the sampling vendor purged the nonworking landline or inactive cell phone telephone numbers, a process that is inexpensive and easy to implement. The effect of purging has more impact on the landline screening cost than on the cell phone sample because a larger proportion of numbers are screened out. Approximately 65 percent of landline telephone numbers were purged. In contrast, only 9 percent of the cell phone numbers were purged.

After the nonworking numbers were dropped, a reverse telephone match was done to match addresses to the landline numbers. As part of the main CHIS protocol, a pre-notification letter was sent to all landline cases with a matched address. Both landline and cell phone numbers were called according to a specified protocol (14 call attempts for a no-contact case, for a maximum of 23 total calls for a case for both screener and extended interview). During data collection, sampled telephone numbers were assigned a final disposition code depending on the result of the calling protocols. At the end of the interview, respondents were asked to confirm they were residents of Sonoma County. There were 443 respondents in the main CHIS sample (382 cases from the landline and 61 from the cellphone sample).

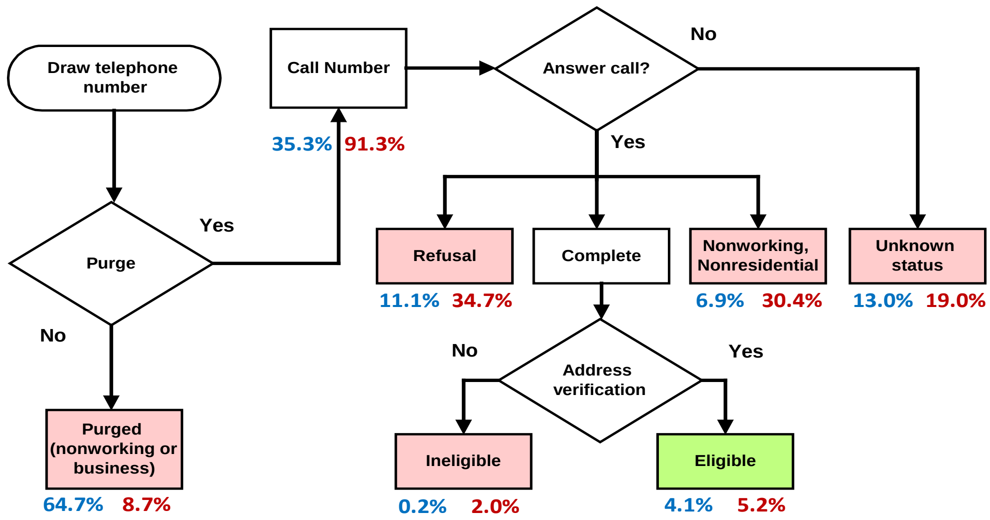

Figure 1: Data collection protocol for the RDD sample

It is not straight forward to compare the performance of these designs. One indicator is the rate of completed cases per sample released or completion rate. This is an indirect measure of level of effort and cost. The completion rates for the main CHIS sample including only those cases sampled in Sonoma were 4 percent for landline and 5 percent for cell phone. If the purged sampled cases are excluded, the completion rate is 12 percent for the landline sample and 6 percent for the cell sample.

Figure 2 shows the data collection protocol for the supplemental ABS sample. A simple random sample was drawn from a frame of addresses geocoded into Sonoma County. To decrease data collection costs associated with obtaining phone numbers for the sampled addresses, the address vendor, Marketing Systems Group, reverse matched the addresses to obtain telephone numbers where available. A telephone number was successfully obtained for almost half (47 percent) of the sampled addresses.

The matched telephone numbers were called following the same telephone protocol used in the main CHIS sample as indicated on the left panel of the flow chart in Figure 2. As in the main CHIS protocol, there was an address verification step. However, because of errors in the matching process, it was necessary to confirm not only that the respondent was a resident of Sonoma County but also that he or she resided at the sampled address.

If a telephone match was not available, then an invitation letter was mailed to the sampled address requesting a telephone number, as indicated in the middle panel of Figure 2. The packet mailed to the sampled households included a cover letter signed by the director of CHIS, a list of frequently asked questions, and a one-page form with a telephone number request. This was followed up with a reminder postcard. A valid telephone number was obtained in 15 percent of the addresses without a telephone match. If a form was received with a valid telephone number, then the telephone was dialed using the telephone protocol described previously, as shown the right-side panel in Figure 2. There were 481 completed adult interviews from the ABS supplemental Sonoma sample with a 9 percent overall completion rate for the ABS supplemental sample.

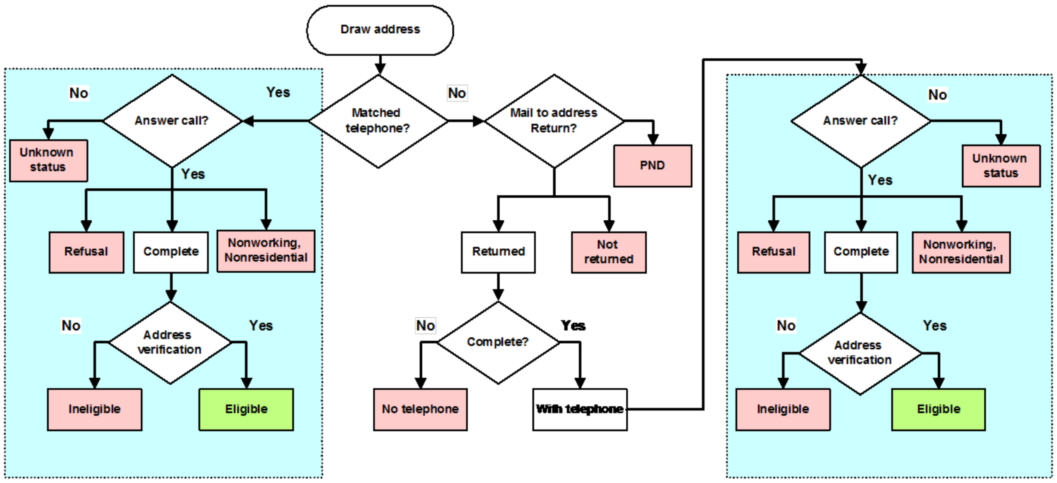

Figure 2: Data collection protocol for the ABS sample

Comparing the data collection protocols for the CHIS main sample and the ABS supplemental sample in Figures 1 and 2 highlights the added complexity of using an ABS design to recruit telephone respondents compared with using an RDD design. However, it is hard to evaluate these protocols without more detailed cost information than is available for this analysis. For example, purging procedures were very effective in increasing the efficiency of screening for respondents in the landline sample, but were not so effective in the cell phone sample. The overall efficiency of purging will depend on how the telephone sample is allocated between the landline and cell phone frames. In contrast, in the ABS sample, matching telephone numbers to sampled addresses reduced the increased costs associated with obtaining phone numbers for a sample of addresses, but reverse matching was successful in less than half of the sampled addresses. In the ABS design, longer data collection periods may be necessary for the mailout procedures and to allow the return of the forms. Furthermore, these designs are not statistically equivalent because the CHIS main sample for Sonoma is part of a larger design that benefits from the overcoverage from surrounding areas.

If a dual-frame RDD design targeting Sonoma is implemented, the survey statistician needs to evaluate the trade-off between the bias of estimates due to undercoverage, screening costs of ineligible cases, and cell phone and landline sample allocation before it can be compared to an ABS approach. However, our analysis compared a design where both the RDD and ABS samples were selected from only Sonoma; here is 24 percent undercoverage in the cell sample component, and 15 percent of the sample is allocated to the cell phone frame in the RDD design. Table 1 summarizes the completion rates for these designs. As in the previous comparison, we examine the number of completed cases per released sample or completion rate The completion rate for the ABS sample is 9 percent, which is higher than the completion rates for both the landline and cell samples

(4 and 5 percent, respectively). However, if we take into account the purged telephone numbers (which are not dialed), the completion rate for the landline sample is 12 percent, higher than for the ABS sample, but not for the cell phone sample (6 percent).

Table 1: Completion rates for RDD and ABS samples

Sample	Completion rate	
	Overall	Excluding purged numbers
Main CHIS landline	4.1%	11.5%
Main cell phone	5.2%	5.7%
ABS supplemental	8.9%	

3.3 Results

The previous section shows how an ABS sample can be used to recruit respondents for a telephone survey. An ABS sample can be a cost-effective method that allows precise geographic targeting with comparable completion rates to an RDD design. The ABS estimates have good statistical properties (i.e., unlike the RDD sample with differential sampling rates or overlapping areas). In this section, we examine the differences in estimates for Sonoma County from the main CHIS RDD sample and the supplemental ABS sample. Although the final objective in CHIS 2013-2014 was to combine the two samples, the inclusion of an independent ABS sample presents a unique opportunity for comparing estimates from the samples. Since data were collected in both samples using CATI, mode effects should not have a differential impact on the differences.

In our analysis, the RDD sample includes all respondents who reported Sonoma County residency regardless of the sampled county. In other words, the estimates from the RDD sample properly reflect all of Sonoma County and the analysis determines whether they produce the same estimates. We did not reweight the sample that includes only cases sampled in Sonoma. Studying a weighting approach that removes the bias due to undercoverage is outside the scope of this study.

In this analysis, nonresponse adjusted weights were used to produce estimates of proportions for 35 variables from the CHIS 2013-2014 adult interview. Separate analysis weights for each sample were created independently using similar weighting procedures. The nonresponse adjusted weights were raked to the same control totals for Sonoma County. Estimated proportions were computed for 17 demographic variables (e.g., marital status, race, ethnicity, and education) and 18 health-related variables (e.g., whether the respondent has diabetes, asthma, or high blood pressure; is covered by Medicare; or has seen a doctor in the past 12 months), as shown in Table A-1 in the Appendix. Table A-1 shows these estimates for the ABS sample and the RDD sample, their corresponding standard errors, and the associated p-values of the t-test statistic for the difference in the population proportions from the two samples. The t-test statistics and p-values were computed using WesVar 5.1 using replication methods accounting for the sample design in both samples (Westat, 2007).

The estimates of the proportions in Table A-1 are graphically represented in Figure 3. The horizontal axis corresponds to the estimated proportion computed using the RDD sample, while the vertical axis corresponds to the estimated proportion computed using the ABS sample. A 45° reference line is included on the table as an indicator of what the results would look like if the estimates had been the same.

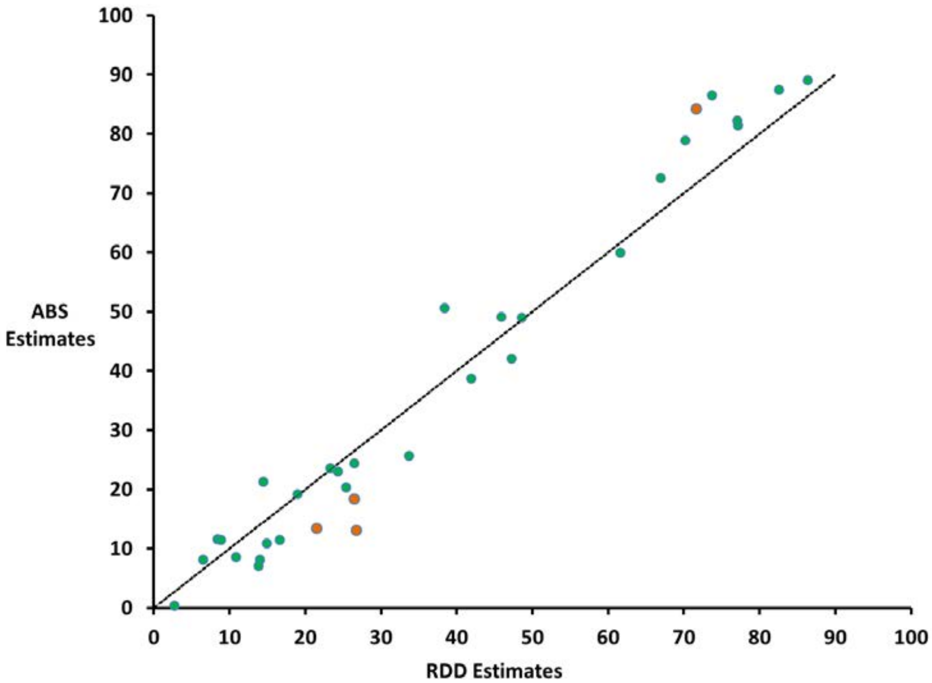

Figure 3: Comparison of estimates of percentages of the ABS sample to the RDD sample

The estimates of the proportions from the RDD and ABS samples are cell respondents that are highly correlated ($R^2 = 0.96$), as illustrated in Figure 3. As shown in Table A-1, only 4 proportions of the 35 compared proportions are found to be significantly different at the 95 percent confidence level. These correspond to the red dots in Figure 3. The analysis shows that the population from the ABS sample is less likely to fall in the lowest income group, more likely to have had alcohol in the past 12 months, less likely to have a health condition that limits physical activity, and less likely to be Hispanic.

The estimates of standard errors of the estimated proportions in Table A-1 are graphically represented in Figure 4. The horizontal axis corresponds to the estimated variance for the RDD sample, while the vertical axis corresponds to the estimated variance computed using the ABS sample. As in the previous figure, Figure 4 also includes a 45° reference line. For the majority of the estimates (69 percent), the sample variances from the RDD sample are larger than the variances from the ABS sample. This is expected because the ABS sample has less weight variation than the RDD sample. After all, the ABS is a simple random sample of addresses whereas the RDD is a stratified sample of telephone numbers drawn at different rates. The correlation is less strong for the standard errors than for the estimates ($R^2 = 0.52$).

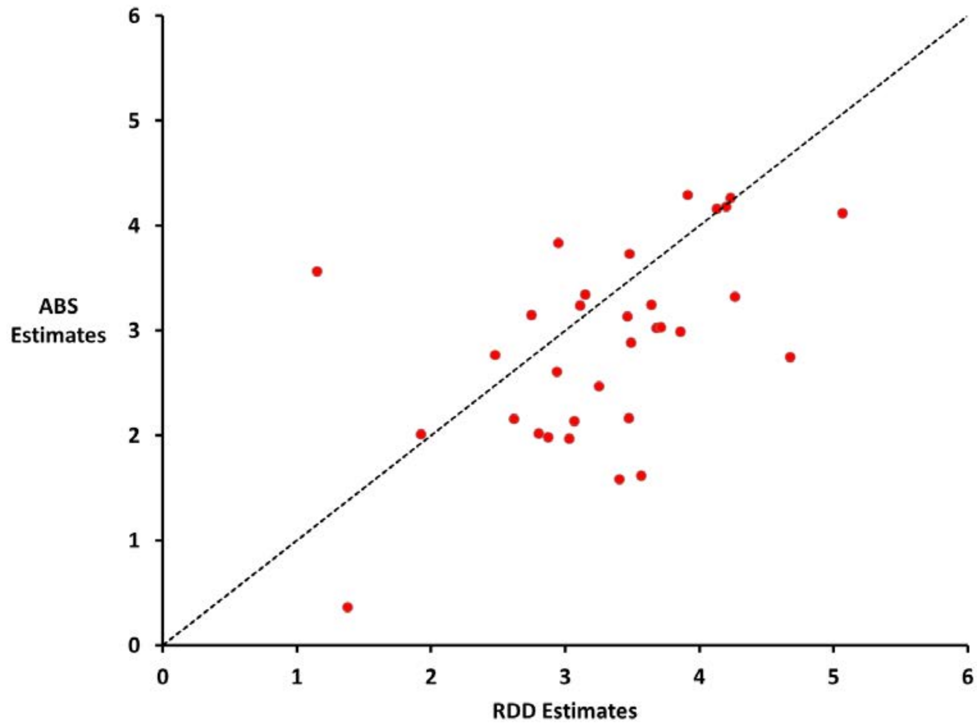

Figure 4: Comparison of estimates of variances from the ABS sample to the RDD sample

4. Discussion

Geographic targeting is challenging for dual-frame RDD designs with both landline and cell phone samples. In contrast, ABS designs, which are gaining in popularity in survey research, are effective at precise geographic targeting. This paper described the operational issues raised by conducting a telephone survey using an ABS sample. We also study the differences between the estimates produced by these samples. The results show it is possible to use an ABS sample to recruit respondents located in a small geographic area for a telephone survey. These results corroborate the findings of Link et al. (2008), who suggest using ABS as a replacement for RDD. The results also expand the small-scale feasibility study in Jans et al. (2013), who explored a similar design that achieved higher completion rates and lower variances than the RDD design.

It is simpler to field a telephone survey instrument with an RDD sample than with an ABS sample because telephone numbers are readily available for the drawn sample. On the other hand, the ABS sample design provides precise geographic targeting, something that is not possible with a cell sample; cell samples may have high rates of both undercoverage and overcoverage. To correct for the undercoverage, neighboring counties would need to be included in the frame, increasing both overcoverage and survey costs. Although the precision in targeting a smaller geographic area in an ABS sample can translate to cost savings, additional steps are needed to link a telephone number to the address. These additional steps, which are not without error, may also necessitate a longer data collection period.

While this study is small and specific to a rural county in California, the results show that both samples produce similar estimates. There are few significantly different results between the two sample designs, at least within the set of variables we compared. Respondents from the ABS sample were less likely to fall in the lowest income group, more likely to have had alcohol in the past 12 months, less likely to have a health condition that limits physical activity, and less likely to be Hispanic.

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Appendix

Table A-1: Comparison of estimates of proportions of RDD respondents and ABS respondents for 35 variables in CHIS 2013-2014

	RDD		ABS		
Variable description	Estimate	Standard error	Estimate	Standard error	Prob>|T|
General health: Health - Fair or Poor	81.47	3.025	77.14	3.679	0.381
Has asthma	11.44	1.983	16.65	2.870	0.131
Has diabetes	8.52	2.020	10.88	2.804	0.518
Has high blood pressure	25.72	2.990	33.71	3.859	0.108
Diagnosed heart disease	8.13	2.010	6.51	1.925	0.575
Had alcohol past 12 months	84.16	3.245	71.65	3.644	0.013
Blind or deaf	11.60	2.606	8.40	2.939	0.415
Difficulty learning, etc.	8.07	2.134	14.01	3.065	0.118
Condition limits physical activity	13.41	1.619	21.50	3.565	0.043
Smoked 100 cigs in lifetime	38.72	4.163	41.92	4.129	0.591
No usual source of health care	89.07	3.237	86.33	3.110	0.542
Delayed care in past 12 months	21.28	3.835	14.42	2.947	0.141
Country of birth: USA	78.94	3.342	70.21	3.147	0.074
Education - Less than HS	10.88	2.158	14.88	2.618	0.275
Education - HS grad or GED	22.97	2.163	24.32	3.476	0.753
Education - Some College	49.13	2.469	45.87	3.250	0.419
Covered by Medicare	24.42	1.580	26.46	3.404	0.603
Covered by Medi-Cal	11.49	2.768	8.89	2.476	0.480
Feel stress: All or most of the time	86.53	6.685	73.71	9.766	0.277
Feel safe in neighborhood	60.01	4.267	61.58	4.233	0.803
All/most calls on cellphone usage	23.70	3.297	24.61	3.981	0.857
Very few calls on cellphone usage	29.91	4.143	22.97	3.332	0.157
Some fast food past week	42.09	4.182	47.24	4.199	0.393
Income 20K or less	13.08	2.746	26.72	4.676	0.011
Income 20K to 70K	50.58	4.119	38.37	5.068	0.065
Income 70K to 135K	23.64	2.886	23.28	3.491	0.935
No sex partners past 12 months	19.23	3.732	18.96	3.478	0.956
More than one sex partner past 12 months	7.10	1.970	13.79	3.032	0.077
Saw doctor in past 12 months	20.36	3.029	25.39	3.712	0.307
Presence of teen in HH	72.54	3.133	66.97	3.463	0.257
Presence of child in HH	82.29	4.296	77.04	3.913	0.341
Race: African American	0.38	0.361	2.73	1.380	0.100
Hispanic	18.40	3.567	26.50	1.150	0.043
Sex	49.00	3.322	48.63	4.263	0.946
Race: White	87.50	3.149	82.58	2.747	0.228
Marital status: Married	58.96	3.560	49.52	4.029	0.078
Marital status: Never married	22.08	2.628	30.90	3.880	0.063