Mode and Address Frame Alternatives to RDD

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Abstract

Valid and reliable public health data are becoming more difficult to obtain through random-digit dial (RDD) telephone surveys. As a result, researchers are evaluating different survey designs (i.e., sampling frame and survey mode combinations) as complements or alternatives to RDD. Traditionally, mail surveys of the general public have been limited by lack of a complete sampling frame of households. More recently, however, advances in electronic record keeping have allowed researchers to develop and sample from a frame of addresses (the U.S. Postal Service Delivery Sequence File), which appears to provide coverage which rivals that obtained through RDD sampling methods. Testing the use of this frame for surveying adults aged 18 years and older across a wide geographic area, a pilot study was conducted as part of the 2005 Behavioral Risk Factor Surveillance System (BRFSS). The pilot compared use of traditional, RDD, telephone survey methodology to an approach using a mail version of the questionnaire completed by a random sample of households drawn from an address-based frame. The findings indicate that higher response rates can be achieved in low response rate states (< 40%) using the mail survey approach as compared to RDD (particularly when two mailings are sent). Additionally, the address frame / mail survey design provided access to cell phone-only households and offered considerable cost savings over the telephone approach. The resulting sample, however, significantly over-represented those with higher levels of education and non-Hispanic whites and under-represented people in less urban areas.

Note: The findings and conclusions of this report are those of the authors and do not necessarily represent the views of Abt Associates, Baruch College, or the Centers for Disease Control.

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INTRODUCTION

For more than 30 years, random-digit dialed (RDD) telephone surveys have been the workhorse of the survey research industry. Over the past decade, however, participation in most RDD telephone surveys has declined due to factors such as the growth of call screening technologies, heightened safety and privacy concerns, and the proliferation of state and federal do not call lists (Steeh et al 2001; Curtin, Presser, Singer 2005). Additionally, the integrity of RDD sampling frames has increasingly been called into question. RDD sampling frames have always excluded the portion of the population (approximately 1.7%) in 2005, who do not have a land-line telephone in their household (Blumberg, Luke, and Cynamon 2006). Additionally, most survey organizations have adopted "list assisted" RDD sampling approaches, which exclude telephone numbers (approximately 3% to 4% of all households) in "zero blocks" -- that is, banks of 100 telephone numbers with no directory-listed households (Brick et al 1995). Noncoverage problems have been further exacerbated with the increased use of cellular telephones, with 6.7% of households reported to be cell-phone only in 2004 and this percentage is expected to increase over time (Blumberg, Luke, and Cynamon 2006). Because most RDD samples are typically drawn from area code-central office code combinations assumed to be land-line numbers (including mixed-use exchanges), most cell-phone-only households are excluded from RDD sampling frames. When we consider all sources of under-coverage in RDD frames (i.e., households with no telephones, those in zero blocks, and cell-phone-only households), the percentage of US households not covered by RDD frames may be as high as 9% to11%.

Moreover, the geographic specificity of numbers in RDD sampling frames is being eroded with the advent of number portability, whereby a person can chose to port their land-line telephone number to a cell phone or vice versa or, in some instances, to change residences but

retain their landline telephone number (Link and Town 2005). This allows individuals, within certain limits, to take their number from one geographic area to another; however, from an RDD sampling perspective, the number would remain in its original area code-central office code bank.

Alternative probability sample designs to RDD of comparable speed, efficiency, and cost are scarce. The growth of database technology has, however, facilitated the development of large, computerized address databases, which may provide an inexpensive alternative to RDD for drawing household samples. One such database, the U.S. Postal Service (USPS) Delivery Sequence File (DSF), contains all delivery point addresses serviced by the USPS (U.S. Postal Service 2005). Initial evaluations of the DSF as a means of reducing the cost of enumerating urban households in area probability surveys have promising results, with estimates that the DSF covers as much as 97% of all U.S. households (Iannacchione, Staab, and Redden 2003; Staab and Iannacchione 2004; O'Muircheartaigh, Eckman, and Weiss 2004). DSF coverage varies significantly, however, with less coverage in more rural and lower income areas. Comparing county-level households counts from the DSF with those from the 2000 Census for the six states participating in the pilot study, we found that the DSF counts were at least 10 percent less than the Census counts in nearly 90 percent of the counties where 25 percent or fewer adults lived in an urbanized area (Link et al. 2005). Despite these limitations, the DSF appears to be a viable sampling frame for household-based surveys, providing access to households without landline telephones that are not accessible by most RDD surveys.

As one of the world's largest RDD telephone surveys, the Behavioral Risk Factor Surveillance System (BRFSS) collects uniform, state-specific data on preventive health practices and risk behaviors linked to morbidity and death among non-institutionalized adults, aged 18

years or older. The median state-level response rate for the survey is approximately 50 percent (CDC 2006). During 2005, we conducted a six-state pilot study of a mailed version of the BRFSS questionnaire using the DSF as a sampling frame and compared the results of this survey with those from the standard RDD BRFSS. To date the DSF has been tested primarily within the context of creating segment housing unit listings for area probability sampling. In this analysis, we extend assessment of the DSF to a comparison with RDD sampling methods for conducting surveys of the general public across a wide geographic area. In particular, we seek to answer the following: How do RDD telephone surveys and DSF-based mail surveys compare in terms of response rates, respondent demographics, and survey estimates? Can DSF-based mail surveys reach households without telephones and cell phone-only households currently excluded from most RDD sampling frames? And, finally, how do these different approaches compare in terms of cost?

MATERIALS AND METHODS

The six states participating in the mail survey were California, Illinois, New Jersey, North Carolina, Texas, and Washington. These states were selected because five of the six (North Carolina being the exception) had annual BRFSS response rates below 50 percent; and, because they were collectively a good representation of the U.S. population, both geographically and in terms of their racial and ethnic mix.

DSF Mail Survey Data Collection

The sample designs for the telephone BRFSS surveys are based on state-specific samples of telephone numbers. For the mail survey pilot, however, the DSF sample frame was based on "deliverable addresses," which included post office (PO) boxes as well as residential addresses. To ensure that coverage was as complete as possible, we included seasonal addresses, vacant

addresses, throwback units (locations with residents who prefer to pick up their mail at the local post office), and drop point addresses (locations where mail is dropped off for residents to pick up, such as a general store in a rural area or a trailer park office).

The DSF frame was first stratified by the Federal Information Processing Standards (FIPS) code within each state. We then drew a systematic random sample of 1,680 addresses from each state for a total of 10,080 addresses.

Embedded within the mail survey pilot were several split sample experiments designed to test the effectiveness of various contacting and within-household selection procedures. These included:

- Inclusion of surname/family name on the mailing envelope -- We asked two different database vendors to match the sampled addresses with any name(s) they could associate with the address. Cases with a surname match were randomized in an equal fashion into one of two groups (i) addressed to "The <Surname> Household or Current <State> Resident" or (ii) "<State> Resident." Cases where a surname could not be matched were addressed to "<State> Resident."
- Postcard reminder -- All cases were equally randomized to one of two groups: (i) received a postcard 1 week after initial questionnaire mailing or (ii) did not receive a postcard.
- Second questionnaire mailing -- All cases were equally randomized to one of two groups: (i) nonrespondents, who received a second mailing after 4 weeks, including cover letter and questionnaire or (ii) nonrespondents, who did not receive a second mailing.
- Alternative within-household selection techniques -- A literature search turned up very little related to selecting one adult at random from a household in a mail survey (Battaglia

et al 2005). Therefore, we developed and tested several techniques for within-household selection. Sampled addresses were randomized equally to one of three respondent selection methods – (i) any adult in the household, with the household deciding who responds (a nonprobability approach hypothesized to have the lowest associated respondent burden, and potentially the lowest level of nonresponse), (ii) adult with the next birthday (based on selection procedures used widely in a number of RDD surveys), or (iii) every adult in the household.

Except for minor wording changes, the mail survey replicated the 75 questions on the 2005 BRFSS core questionnaire. Survey packets included a cover letter and questionnaire booklet. Instructions for requesting a Spanish-language version of the questionnaire were included on the cover in Spanish. Data collection ran from March 15 through May 15, 2005, for California, Illinois, North Carolina, Texas, and Washington and from April 1 through May 30, 2005, for New Jersey. The mail survey data collection procedures were approved by the Institutional Review Board (IRB) of Abt Associates and the IRBs of the six states.

Mail Survey Weighting

The mail survey data were weighted to adjust for probability of selection both at the residential address and within-household respondent selection levels (depending on the type of within household selection used), post-stratified by sex and age of the respondents, then ratio adjusted to equalize weighted state sample sizes. First, household base sampling weights (BSW) were calculated by state. The household base sampling weight for a state equaled the DSF population count of residential addresses divided by the sample size. One could use BSW for combined state-weighted response rate calculations, however, the larger states (California and Texas) would largely determine the resulting rates. It was therefore decided to ratio-adjust BSW so that

the sum of the weights for sample households in each state summed to the average of the total residential addresses across the six states. Next, a design weight (BSW_2) for version 2 (respondent selection = next birthday) completed questionnaires was calculated as BSW times the number of adults in the household, where the maximum value for number of adults in a household was capped at 5. For version 1 (respondent selection = any adult) and version 3 (respondent selection = all adults) completed questionnaires, BSW_2 = BSW. A version 3 (all adults) nonresponse adjustment was made (BSW_3) and calculated as BSW_2 times the ratio: (number of adults in the household/number of adults in household that completed a questionnaire), where the maximum value for number of adults in a household was capped at 5. For version 1 and 2 completed questionnaires, BSW_3 = BSW_2. For all completed questionnaires in a state combined, BSW_3 was post stratified to 2004 population control totals (provided by Claritus) for 13 age by gender cells to produce a post-stratified weight (BSW_4). Males aged 18-24 were combined with males aged 25-34, because of the small sample size in the younger age group. Finally, BSW_ 4 was ratio-adjusted to produce a final weight (FINALWT) such that the sum of the weights in each state equaled the average of the total adult population across the six states. FINALWT was used to produce the estimates presented in the analyses below because it gave each state an "equal" contribution to the combined state estimates (i.e., the estimates were not dominated by California and Texas).

RDD Telephone Survey Data Collection

The mail surveys were conducted in parallel with the monthly RDD data collection in the six participating states. We used telephone survey data for March, April, and May 2005 and weighted the data to adjust for the state-specific sampling designs, post-stratified using the same sex and age categories specified for the mail survey data, and ratio-adjusted them so that the sum

of the final weights in each state equaled the average of the adult population totals across the six states. More details about the BRFSS questionnaire and methodology have been previously published (7) and are also available at http://www.cdc.gov/brfss.

Response Rate Calculations

To maximize comparability between the mail and telephone surveys, outcome disposition codes and response rate calculations recommended by AAPOR were used (AAPOR 2004). AAPOR provides a set of case outcome codes for RDD telephone surveys and mail surveys of specifically named persons. For the telephone survey the original BRFSS disposition codes were mapped to the AAPOR specified codes and response rates were calculated using AAPOR response rate formula #4. Because the AAPOR mail survey disposition codes apply to surveys where the name of the respondent is known up-front, some modifications were required to deal with sampled cases which might not be identified with an eligible residence. All cases in which some type of return (either from the respondent or from USPS) was not received were considered to have unknown eligibility and the residency rate for these sampled addresses was estimated using the sample for which eligibility was determined. Cases which were returned as undeliverable from the USPS were coded according to the reason given for not being able to deliver the survey packet. Those where the packet could not be delivered due to an address problem, address no longer in service, or the unit was vacant were treated as ineligible, including those marked "cannot be delivered" (no reason given), "cannot be delivered as addressed," "insufficient address," "No mail receptacle," "no such number," "PO box closed," and "vacant."

Cost Calculations

Cost is an important component in the evaluation of any survey design. The data collection costs per 1,000 completed interviews was calculated for both the telephone and mail surveys using (1)

actual unit costs for materials and supplies based on the pilot study experience, (2) production statistics from the pilot effort, and (3) estimates of industry averages for direct hourly rates and indirect cost rates (i.e., fringe benefits, general and administrative expenses, indirect technical costs, and materials support expenses). Other costs assumed to be nearly equivalent regardless of the survey design were not included, such as overall project management, survey design development, and post-data collection weighting and analysis.

Analysis

The analysis was conducted in four parts. First, response rates are compared across the mail and telephone survey and across different treatment groups within the mail survey. Second, population distributions across key demographic variables are compared, with additional comparisons made to estimates from the Current Population Survey – a high response rate survey which serves as a "gold standard" for comparison. Third, we used the self-reports of survey participants to assess the prevalence of four health conditions (asthma, diabetes, high blood pressure, and obesity) and four risk behaviors (smoking, binge drinking, HIV testing, and HIV risk behaviors). Asthma, diabetes, and high blood pressure were assessed by asking participants, "Have you ever been told by a doctor, nurse, or other health professional that you have [condition]?" Obesity was assessed on the basis of respondents' body mass index (BMI), which was calculated from their self-reported height and weight, with respondents classified as obese if their BMI was ≥ 30 kg/m^2. Respondents were classified as "current smokers" if they reported currently smoking every day or some days; they were considered "binge drinkers" if they reported having consumed five or more drinks at least once during the preceding 30 days; they were considered to have been tested for HIV if they responded "yes" to the question, "Have you ever been tested for HIV?"; and, they were considered to have engaged in behaviors linked to the transmission of HIV if they indicated that they had, within the previous year, used intravenous drugs, been treated for a sexually transmitted or venereal disease, given or received money or

drugs in exchange for sex, or had anal sex without a condom. Finally, we calculate the costs of completing 1,000 surveys using the RDD telephone survey approach and compare that with the costs associated with the DSF mail survey approach.

We conducted all analyses using SPSS Version 13.0 with Complex Samples module and used confidence intervals (CI) of 95 percent to determine whether differences were statistically significant (SPSS 2004).

RESULTS

We received a total of 3,010 completed mail surveys from the six states. Overall and state-specific response rates for the surveys are provided on Table 1. For all states except North Carolina, response rates were modestly higher in the mail survey than the telephone survey. The differences were larger and statistically significant for four of the five states when we consider only cases in the mail survey targeted to receive two questionnaire mailings.

For the mail survey, overall response rates varied by the type of within-household selection method used (35.4 percent for the "any adult" method, 33.2 percent for the "next-birthday" method, and 28.0 percent for the "all-adults" method). The response rate for the "all-adults" method was calculated by multiplying the percentage of household that returned at least one completed questionnaire (32.9 percent) by the percent of all adults in those households who returned a completed questionnaire (85.1 percent). More detailed analysis of differences by within-household selection method is available elsewhere (Battaglia et al 2005).

Next, we calculated the response rates for the various treatment groups (e.g., combinations of surname use, postcard reminder, and second mailing). As shown in Table 2, we obtained the highest response rates for the groups where a name was available but not used and a second questionnaire was mailed. The addition of a post card reminder to these two factors

improved the response rate only slightly from 44.3% to 44.9%. The lowest response rates were for the groups where no surname was identified and no second mailing was sent.

Comparison of Demographic Characteristics

We also looked at the demographic characteristics obtained using the telephone and mail surveys and compared these to results from the 2003 Current Population Survey (CPS). The CPS was used as a "gold standard" against which the BRFSS telephone and mail results were compared. Estimates for the telephone and mail surveys were post-stratified to adjust for sex and age differences using 2000 Census estimates updated for 2004 by Claritus. Both the telephone and mail surveys differed significantly from the CPS estimates in a number of characteristics (Table 4). Most striking were the differences in education levels of the respondents. In the telephone survey, 59.7% reported having at least some college education, as did 71.8% of those responding to the mail survey. Both of these are higher than the 53.8% estimated by the CPS. The mail and telephone surveys also differed significantly from the CPS estimates with respect to metropolitan statistical area (MSA) status. Of the mail survey respondents, 89.7% lived within an MSA and 10.3% lived outside of an MSA (i.e., in a less urbanized area). This latter percentage compares to 13.2% from the RDD survey and 13.8% from the CPS, who live in outside of an MSA area. In terms of other demographic groups, the telephone survey overestimated the percentages of white, non-Hispanics and married people and underrepresented the percentages of persons with no children in the household and households with three or more adults.

Similarly, the mail survey overestimated the percentages of white, non-Hispanics, households with family incomes of $50,000 or more, and married people and underestimated the percentage of households with three or more adults. The mail survey also differed significantly

from the telephone survey with regards to household education level and income as well as number of children and adults in the household.

Next, we examined the success of the mail survey in reaching cell-phone-only households and households with no telephone coverage – both of which are missed by RDD surveys. We made comparisons with estimates from interviews conducted January through June, 2005, as part of the National Health Interview Survey (NHIS), a face-to-face survey with a relatively high response rate. As shown in Table 5, 6.5% of the adults responding to the DSF-based mail survey indicated that their household could only be reached by cell phone. This was similar to the 6.7% reported for the NHIS (Blumberg et al., 2006). Approximately 1% of mail survey respondents said they had no telephone access in their household compared to 1.7% of those interviewed in the NHIS.

Prevalence Estimates by Survey Type

We found that the mail survey produced significantly higher prevalence estimates than the telephone survey for binge drinking, high blood pressure, and behaviors associated with HIV transmission, but that the telephone survey produced higher estimates for HIV testing. These differences persisted even after we used logistic regression to adjust for other potential confounders, including respondents' state of residence, sex, race/ethnicity, age, education, and health care coverage. The multivariate model also indicated increased odds of obesity among mail respondents after adjusting for other potential confounders.

Cost Comparisons

The operational costs of conducting the telephone survey were nearly two-and-a-half times greater than the costs associated with the mail survey: $79,578 per 1,000 completed interviews for the telephone survey versus $30,919 per 1,000 completed interviews for the mail survey.

Although the cost of materials was higher for the mail survey (loaded rates: $3,938 for telephone survey, $10,211 for mail survey), mounting telephone surveys is much more labor intensive for the same number of completed interviews compared to a mail survey (loaded rates: $75,640 for telephone survey, $20,708 for mail survey). The higher indirect rates for labor (estimated to average 150%) compared to those for materials and supplies (estimated to average 25%) further exacerbated these difference.

DISCUSSION

Mail surveys conducted with respondents sampled from addresses listed in the DSF show some promise as an alternative or complementary approach to RDD surveys of the general population. The mail survey approach had several advantages. First, the mail survey response rates were significantly higher than those obtained in the RDD surveys in five of the six states when a second questionnaire mailing was used. The benefit of a second questionnaire mailing is consistent with the findings of other mail surveys (Dillman 2000). Use of a reminder post-card one week after the initial mailing also appears to provide a modest boost to response rates. Additionally, there were clear differences in participation rates between those with addresses in which a surname was found and those where a surname could not be identified, with the former being more likely to respond regardless of whether the name was actually used on the mail envelop. This is similar to the differences found in RDD surveys between households in which an address can be matched to a database and those where an address cannot be matched (Link and Mokdad 2005a). It appears that persons who are more readily identifiable in public databases, such as those used for surname or address-matching, tend to be more willing to participate in surveys than those who are more difficult to identify. Although the differences in participation between the two surname groups were not statistically significant, there are

potential issues which might make not using the name, even when available, preferable. If the surname match is incorrect, household members may be more likely to discard the mailing without opening it. Although the differences in participation rates seen here were not statistically significant, the group where a surname was available but not used had the highest overall response rates. Use of a surname may also influence respondent selection, particularly in households where adults may not share the same last name. Finally, use of surname may raise concerns about confidentiality among some respondents leading them to alter their responses, particularly to sensitive questions.

Second, the two surveys also produced similar prevalence estimates for four of the eight indicators. The higher estimates produced by the mail survey for binge drinking and engaging in behaviors linked to HIV transmission are in line with those from other studies showing respondents to be more likely to give socially desirable responses and less likely to report accurately about sensitive or stigmatized behaviors in interviewer-administered surveys than in self-administered surveys (Link and Mokdad 2005b; Turner, Ku, and Rogers 1998; Dillman et al 1996).

Third, the mail survey provided access to households with only cell phones and to a smaller degree to households with no telephone coverage. The former group is increasingly becoming a focus of concern among researchers, while the latter group has always been unreachable by telephone survey. Finally, the mail survey was considerably less costly to conduct. For the same number of completed interviews, the telephone survey was more than twice the cost of the mail survey.

The mail survey approach did, however, have a number of drawbacks. First, improvement in response rates were obtained only in those states where the RDD response rates

were low (i.e. below 40%). In the one state, North Carolina, where the RDD response rates was above 45%, the mail survey did not out perform the telephone survey.

Second, the mail survey obtained responses from a significantly lower percentage of persons who do not live in an MSA and a much higher percentage of persons with some college or more education than did either the RDD survey or the CPS. The same is true of the percentage of non-Hispanic whites who completed the surveys. This skewed distribution across these key demographic groups raises some concerns about potential bias in the estimates (see Link et al 2005 for more detailed analysis of this issue). For several other characteristics, such as marital status and number of children in the household the mail survey performed somewhat better than the RDD survey in comparison to the CPS.

Third, use of the mail survey approach would likely force some fundamental changes in the way in which a study, such as BRFSS, currently operates, particularly with regards to curtailing the flexibility of the survey. The mail survey requires a longer fielding period (typically 8 weeks or more) compared to the current monthly schedule for the BRFSS telephone survey. Use of a mail survey would also reduce the length and flexibility of the BRFSS questionnaire. The telephone version of the BRFSS contains a core survey of 70-75 questions (asked in all states), optional modules of 1-20 questions (standardized topic modules which can be adopted by the states), and state-added question modules of 1 to 50 questions (typically unique to each state, focusing on state-specific health issues). The 2005 mail survey pilot tested only the core questionnaire. Lengthening the mail questionnaire further could increase respondents' reluctance to complete the survey and customizing each state survey to include the optional or state-added modules would significantly increase the operational complexity of administering the survey.

This study has some limitations. First, the DSF frame does not provide universal coverage of all households, particularly in more rural and lower income areas. Second, the number of completes obtained in each of the treatment groups (i.e., combinations of surname use, postcard reminder, and second mailing) did not allow us to look at demographic characteristics of respondents by these different groups. Third, the study was conducted in six states, which may not be representative of either the nation or other populations.

A great deal more study is needed before use of the USPS DSF can be recommended as a standard approach to sampling and mail surveys as the preferred mode of interviewing for an on going survey such as the BRFSS. The findings do, however, offer encouragement, particularly for states and areas with low RDD response rates, urban areas where DSF coverage is higher, and for surveys where all households are eligible. Future research efforts should continue to evaluate the expansion of DSF coverage as more rural areas adopt city-style addresses that conform to 911 emergency number rules. Surveys for which DSF serves as a sampling frame could perhaps be improved by the use of a "mixed-mode" or a "dual-frame" approach. A mixed-mode approach involving a mail survey with telephone follow-up of nonrespondents may be the optimal design, given that approximately 70 percent of the addresses of participants in this pilot could be matched to telephone numbers. As household access to high-speed Internet services increases, Web surveys could also be incorporated into such mixed-mode survey designs. As part of a dual-frame approach, the DSF and RDD frames could be used in complementary fashion, with the RDD frame used primarily in more rural areas where DSF coverage is poorer, and the DSF frame used primarily in more urban areas to provide access to households without landline telephones.

A follow-up to the 2005 pilot study is currently in the field, building on the lessons learned from the earlier. Two alternative survey designs to the current RDD approach are being tested in six states (California, Texas, Florida, Minnesota, South Carolina, and Massachusetts). The first alternative used RDD methods to draw a sample of telephone numbers, which were reverse-matched to identify addresses linked to the telephone number, while the second alternative started with an address-based frame (the US Postal Service Delivery Sequence File) and matched the addresses to identify telephone numbers. For each, a mail survey version of the 2006 BRFSS core questionnaire was used with computer-assisted telephone interviewing (CATI) follow-up of nonrespondents after 5 weeks. Sampled telephone numbers to which no address could be matched were sent directly to CATI for contacting and interviewing. The alternative designs are being run in parallel with the on-going RDD-based BRFSS in these states, with a target of 4,800 completed interviews per design. Data collection is scheduled to be completed in July 2006. The results will further inform our efforts to assess the feasibility of using DSF-based approaches as possible future alternatives or complements to RDD surveys.

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Table 1. Comparison of DSF mail survey and RDD telephone survey Response rates by state and experiment condition

	Response Rates[1]		
State	RDD telephone survey % (n)	DSF mail survey: All cases % (n)	DSF mail survey: cases in 2nd mailing group[2] (n)
California	29.4 (5,771)	31.8 (1,266)	39.2*** (597)
Illinois	35.8 (3,323)	36.2 (1,356)	42.8*** (671)
New Jersey	22.5 (14,965)	23.2 (1,250)	30.5*** (614)
North Carolina	45.8 (9,782)	36.3*** (1,200)	42.5 (602)
Texas	31.1 (6.902)	35.5** (1,122)	44.4*** (543)
Washington	34.1 (17,304)	39.9*** (1,334)	44.9*** (626)

RDD=random-digit dialed; DSF=Delivery Sequence File
(n) = estimated number of households.
Significance based on comparisons with RDD telephone survey: * = p<.05, **= p<.01, ***= p<.001
[1] Response rate calculated using American Association for Public Opinion Research Response Rate Formula #4 (AAPOR 2004).
[2] Includes all cases randomly assigned to this treatment group, including those which complete the survey on the first mailing and did not require a second mailing.

Table 2. Response rate by survey design group

Treatment Group	Estimated eligible households	Response rate[1]
Name not used, postcard, second questionnaire	703	44.9
Name not used, no postcard, second questionnaire	709	44.3
Name used, postcard, second questionnaire	726	42.4
Name used, no postcard, second questionnaire	714	38.1
No name match, postcard, second questionnaire	440	33.9
Name not used, postcard, no second questionnaire	716	33.0
Name used, postcard, no second questionnaire	707	31.2
No name match, no postcard, second questionnaire	428	29.7
Name not used, no postcard, no second questionnaire	710	29.0
Name used, no postcard, no second questionnaire	707	28.4
No name match, no postcard, no second questionnaire	494	21.3
No name match, postcard, no second questionnaire	486	19.6

[1] Response rate calculated using American Association for Public Opinion Research Response Rate Formula #4 (AAPOR 2004).

Table 3. Comparison of weighted demographic characteristics, DSF mail survey, RDD telephone survey, and Current Population Survey (CPS)

Demographic characteristics	CPS population estimates %	RDD telephone survey %[1]	DSF Mail survey %[1]	Significance levels RDD -vs- CPS	DSF -vs- CPS	RDD -vs- DSF
Sex				n.s.	n.s.	n.s.
Male	48.5	48.7	48.3			
Female	51.5	51.3	51.7			
Age				n.s.	n.s.	n.s.
18 – 34	32.6	32.2	32.0			
34 – 54	29.4	30.6	30.5			
55 – 64	23.2	21.5	22.1			
65+	14.8	15.6	15.4			
Race				***	***	***
White, non-Hispanic	64.9	68.5	76.1			
Other	35.1	31.5	23.9			
Education				***	***	***
Less than high school	16.9	13.7	7.8			
High school diploma / GED	29.3	26.5	20.4			
Some college or more	53.8	59.7	71.8			
Income				n.s.	*	**
< $50,000	53.6	54.5	51.4			
$50,000+	46.4	45.5	48.6			
Marital status				***	**	n.s.
Married/couple	56.6	60.2	59.1			
Not married/single	43.4	39.8	40.9			
Number of children in household				***	n.s.	***
None	59.8	56.8	61.0			
One or more	40.2	43.2	39.0			
Number of adults in household				**	***	***
One	16.2	16.7	19.3			
Two	54.9	56.2	59.5			
Three	28.9	27.1	21.2			
Metropolitan statistical area (MSA)[2]				*	***	***
In MSA	86.2	86.8	89.7			
Not in MSA	13.8	13.2	10.3			
[n]	[32,963]	[18,780]	[3,010]			

CPS = Current Population Survey; RDD = random-digit dialed, DSF = Delivery Sequence File
Significance: * = p<.05, **= p<.01, ***= p<.001

[1]Data are weighted to adjust for sample design , post-stratified by sex and age, and ratio adjusted so state sample sizes are equivalent.

[2]Metropolitan Statistical Area for the telephone and mail surveys was based on a Core-Based Statistical Area (CBSA) with at least one urban area with a population of 50,000 or higher. MSA for the March 2004 CPS was based on pre-CBSA Metropolitan Areas.

Table 4. Percentage of adults by type of household telephone access

Household telephone access	National Health Interview Survey[1] % (95% CI)	BRFSS DSF mail survey % (95% CI)
Landline	91.6 (91.1, 92.1)	92.6 (90.0, 94.0)
--Landline only	---	*14.9 (13.5, 16.4)*
--Landline and cellular phone	---	*77.7 (75.7, 79.6)*
Cellular phone only	6.7 (6.2, 7.2)	6.5 (5.1, 8.2)
No telephone	1.7 (1.5, 1.9)	1.0 (0.6, 1.4)
[n]	[33,614]	[2,947]

[1] Based on interviews NHIS conducted January-June 2005. Source: Stephen J. Blumberg, Julian V. Luke, and Marcie L. Cynamon. 2006. "Telephone coverage and Health Survey Estimates: Is Concern about Wireless Substitution Warranted?" *American Journal of Public Health* (forthcoming).

Table 5. Prevalence estimates for various health conditions and behavioral risk factors among U.S. adults, by survey design, and adjusted odds ratios comparing results from the mail and telephone surveys

	Prevalence estimates				Adjusted odds ratios[1]	
	RDD telephone survey		DSF-based mail survey		RDD telephone survey	DSF-based mail survey
Health condition / risk factor	n	% (95% CI)	n	% (95% CI)	AOR[2]	AOR (95%CI)
Asthma	18,737	12.2 (11.5, 12.9)	2,941	13.7 (12.1, 15.5)	1.00	1.14 (0.97, 1.35)
Diabetes	18,760	7.8 (7.4, 8.3)	2,984	7.8 (6.9, 8.9)	1.00	1.05 (0.89, 1.23)
High blood pressure	18,748	26.3 (25.4, 27.1)	2,958	29.7 (27.6, 31.8)	1.00	1.22 (1.07, 1.39)
Obese (BMI > 30)	17,272	21.2 (20.4, 22.1)	2,910	23.0 (21.1, 25.1)	1.00	1.17 (1.04, 1.34)
Current smoker	18,705	18.9 (18.1, 19.8)	2,956	18.3 (16.3, 20.4)	1.00	1.01 (0.86, 1.17)
Binge drinking	18,351	13.1 (12.3, 14.0)	2,951	20.3 (18.1, 22.7)	1.00	1.80 (1.51, 2.13)
Tested for HIV[3]	13,534	41.5 (40.3, 42.7)	2,143	37.5 (34.8, 40.3)	1.00	0.80 (0.70, 0.92)
HIV risk behaviors[3]	13,801	4.2 (3.7, 4.8)	2,130	7.1 (5.4, 9.3)	1.00	2.03 (1.41, 2.91)

RDD = random-digit dial; DSF = Delivery Sequence File; AOR = adjusted odds ratios; CI = confidence interval
Note: Data were weighted to account for sample design and post-stratified to sex-age totals for each state. The final weights were ratio adjusted to equalize the number of cases across states.
[1] Models were adjusted for respondents' state of residence, sex, race, age, education, and having health care coverage.
[2] Reference category.
[3] Questions not asked of respondents age 65 years or older

Table 6. Cost comparisons per 1,000 completed interviews for conducting and RDD telephone survey versus a DSF-based mail survey

	RDD telephone survey	DSF mail survey
Assumptions:		
Number of sampled telephone numbers / addresses (per 1,000 completed interviews)[1]	5,000	3,350
Cost calculations for materials/supplies:		
Telephone sample ($0.08 per case) / mail sample ($0.11 per case)[2]	$400	$369
Telephone connect charges ($0.55 per case) [2]	$2,750	-na-
Printing and postage for mail survey package (@ $6.80 per address)[2]	-na-	$6,800
Return postage (@ $1.00 per completed interview) [2]	-na-	$1,000
Subtotal for direct cost of materials/supplies	*$3,150*	*$8,169*
Subtotal for indirect costs of materials/supplies (@ 25%)[3]	*$788*	*$2,042*
Total cost for materials/supplies (direct and indirect)	**$3,938**	**$10,211**
Cost calculations for labor:		
Hours of interviewer time required (@ 2.75 hours/completed interview)[1]	2,750 hrs	-na-
Hours to print and assemble mailing packages (@ 100 packages/hour) [1]	-na-	34 hrs
Hours of receipt/control time required (per 1,000 completed interviews) [1]	-na-	500 hrs
Hours of data entry time required (per 1,000 completed interviews) [1]	-na-	219 hrs
Hours of supervisor/monitor/quality control time required (@ 25% of interviewer / receipt-control / data entry time)[3]	688 hrs	188 hrs
Interviewer / receipt-control / data entry time ($8.00 per hour)[3]	$22,000	$6,024
Supervisor or monitor time ($12.00 per hour) [3]	$8,256	$2,259
Subtotal for direct labor costs	*$30,256*	*$8,283*
Subtotal for indirect labor costs, including fringe benefits (@ 150%)[3]	*$45,384*	*$12,425*
Total cost for labor (direct and indirect costs)	**$75,640**	**$20,708**
Total cost of materials/supplies & labor (absent fee/profit) per 1,000 completed interviews:	**$79,578**	**$30,919**

[1] Based on production statistics from pilot study.
[2] Based on cost data from pilot study.
[3] Based on estimates of average rates across survey research industry.