

## COVERAGE ERROR AND COST ISSUES IN SMALL AREA TELEPHONE SURVEYS

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**Keywords:** Telephone Surveys, Coverage Error, Survey Costs

A telephone survey of the general public is limited to residents who live within a specific geographic area. Often the boundaries of the geographic area do not match the geographic boundaries of the telephone prefixes that reach households in the area of interest (cf. Lavrakas, 1993; pp. 31-32).

Little has been reported regarding the best approach to take when faced with this sampling challenge, especially in small area samples where the problem is likely to be greatest. As is the case in many decisions about survey implementation, a trade-off must be considered in balancing Coverage Error with survey costs (cf. Groves, 1989; Henry, 1990; Lavrakas, 1993). Coverage Error will result if the sampling frame does not well represent the target population. Therefore, a number of factors need to be considered by survey researchers before a sampling method is chosen in small area telephone surveys.

When the geographic area in which a telephone survey needs to be conducted is quite small, random-digit dialing (RDD) is likely to reach many households outside the targeted area. This characteristic of RDD will have cost implications due to the expense of screening out those households that are not located within the target area. How well the household screening sequence used by the interviewers works to screen "in" households within the target area (i.e., avoiding Errors of Omission) and to screen "out" households outside the target area (i.e., avoiding Errors of Commission) will determine the extent to which Coverage Error might reduce the accuracy of the data gathered (cf. Lavrakas, 1993; p. 118-119).

Coverage Error might also be a problem when a reverse telephone directory is used as the sampling method in small area telephone surveys. Since the information listed in a reverse directory is at least a few months old at the time of publication, households with listed telephone numbers (i.e., those that can be printed in a reverse directory) might be located at addresses that are different from those published. More importantly, it is well documented that households that choose not to list their telephone numbers are qualitatively different from households that do choose to list their telephone numbers. For example, unlisted households are more

likely to be non-White and to have a greater fear of crime (cf. Lavrakas, 1993; p. 34).

These known differences between households that list their telephone numbers and those that do not may be crucial factors to consider when choosing a sampling method. Researchers should consider the likelihood that such differences may affect any policy implications drawn from the survey data before a sampling method is chosen.

### METHODOLOGY

This paper presents methodological findings from a telephone survey conducted in Spring, 1993, by the Northwestern University Survey Laboratory, of 2,573 City of Chicago residents, age 18 years and older. The survey was part of a large-scale evaluation research project studying the implementation of a new "community policing" anti-crime strategy by the Chicago Police Department. Interviews were conducted in English and in Spanish with the residents of nine Chicago community areas. Five of the areas were separate police districts and the other four areas were selected because they matched the residential demographics and crime rates of the five police districts. In none of these nine areas did the telephone prefix boundaries match the community area boundaries.

For this study, a decision was made to sample households in each of the nine areas via two sampling frames: 1) a Chicago reverse directory (RVD), and 2) random-digit dialing with geographic screening for eligibility (RDD). This decision was primarily based on cost considerations. The RDD approach with geographic screening was known to be significantly more expensive than the RVD approach. In particular, although RDD should reach a sample of households with less potential Coverage Error (i.e., it would reach households with unlisted telephone numbers), the proportion of households needing to be screened out due to geographic ineligibility was estimated to be between 50%-80%. Another factor in the decision to use two sampling frames was that the researchers could conduct post hoc analyses to determine what differences in the substantive data, if any, were associated with the type of frame. If differences were found, post-sampling adjustments might be applied to correct for any meaningful differences in the data gathered.

A geographic screening sequence was developed for the RVD and RDD samples to allow interviewers to screen households for geographic eligibility. The geographic screening sequences started with a zip code verification for both samples. For the RVD sample, the interviewer proceeded with the respondent selection sequence if the household responded to the zip code verification with an eligible zip code (see Figure 1). In the case of the RDD sample, the interviewer proceeded with a street screener sequence before continuing with the respondent selection sequence when the household responded with an eligible zip code (see Figure 2).

A pilot test of the screener was conducted in February, 1993, using telephone numbers generated by RDD. Since the RVD screening sequence was simply a less complicated version of the RDD sequence, a decision was made to include only the RDD screener sequence in the pilot test. The pilot test indicated that the screening sequence worked well. Less than three percent of the numbers that were screened *out* were later determined through a verification process to be eligible

(i.e., geographically within-scope); and, less than threepercent of the numbers that were screened *in* were later determined to be ineligible (i.e., geographically out-of-scope). Thus, it was very effective (>95%) in avoiding false positives (Errors of Commission) and avoiding false negatives (Errors of Omission).

The RDD numbers were created by computer with a modified Mitofsky-Waksberg two-stage process that maximized the efficiency of reaching working household telephone numbers. The RVD numbers were selected from the most recent Hanes reverse directory for Chicago. This had to be done manually because both the boundaries of the community areas and the layout of many streets within the areas from which proportional sampling was done, were quite irregular. It is important to note that in this survey project, the cost of the programming needed to draw a geographically representative sample from a computer database of the Hanes directory would have exceeded the cost of drawing it manually.

Figure 1:

1993 CHICAGO COMMUNITY POLICING EVALUATION PROJECT  
REVERSE DIRECTORY SAMPLE INTRODUCTION/SELECTION SEQUENCE  
DISTRICT #24

Hello, is this the \_\_\_\_\_ household? **[IF NOT THE HOUSEHOLD NAME ON THE CALL-SHEET, VERIFY THE TELEPHONE NUMBER. IF CORRECT NUMBER BUT NOT CORRECT NAME, VERIFY ADDRESS.]**

**CONTINUE WITH ELIGIBLE HOUSEHOLD:**

My name is \_\_\_\_\_ and I am calling from the Northwestern University Survey Laboratory (in Evanston).

We are conducting a very important survey of residents in your part of Chicago to ask people about how things are going in their neighborhood and, in particular, about public safety issues.

**OPTIONAL:** (The findings of this study will be sent to the Mayor and Superintendent of Police to help improve services to the public, but your household will never be identified. All information you provide us is kept strictly confidential and I really need and will appreciate your household's help.)

**OPTIONAL:** (This survey may take about 20-25 minutes to complete, but your cooperation is very important to the success of this study.)

First, we want to make sure we've reached people in the correct zipcodes for this study. Would you please tell me your zipcode?

**[CIRCLE ZIPCODE]**

60626

60645

60659

60660

OTHER: \_\_\_\_\_

**IF NOT AN ELIGIBLE ZIPCODE POLITELY END:  
"Thank you for your assistance, but we are not  
interviewing residents in that zipcode at this time."**

For this survey, I need to speak with the person in your household, 18 years of age or older, who had the last birthday [I.E. MOST RECENT BIRTHDAY]. (Would that be you?)

**[PROCEED TO QUESTIONNAIRE ONCE SPEAKING TO ELIGIBLE ADULT]**

Figure 2:

1993 CHICAGO COMMUNITY POLICING EVALUATION PROJECT

RDD SAMPLE INTRODUCTION/SELECTION SEQUENCE

DISTRICT #24

Hello, my name is \_\_\_\_\_ and I am calling from the Northwestern University Survey Laboratory (in Evanston).

We are conducting a very important survey of residents in your part of Chicago to ask people about how things are going in their neighborhood and, in particular, about public safety issues.

OPTIONAL: (The findings of this study will be sent to the Mayor and Superintendent of Police to help improve services to the public, but your household will never be identified. All information you provide is kept strictly confidential and I really need and will appreciate your household's help.)

OPTIONAL: (This survey may take about 20-25 minutes to complete, but your cooperation is very important to the success of this study.)

Have I reached \_\_\_\_\_? [VERIFY TELEPHONE NUMBER. -- PLEASE SAY "THANK YOU" WHEN VERIFIED]

S1. And we want to make sure we've reached people in the correct zipcodes for this study. Would you please tell me your zipcode? [CIRCLE ZIPCODE]

- 60626 [SKIP TO R1]
60645 [SKIP TO S2]
60659 [SKIP TO S3A]
60660 [SKIP TO S4]
OTHER: \_\_\_\_\_ [INELIGIBLE; DISP. #20]

IF NOT AN ELIGIBLE ZIPCODE POLITELY END: "Thank you for your assistance, but we are not interviewing residents in that zipcode at this time."

FQR 60645:

S2: Do you live between Kedzie Avenue and Lake Michigan [I.E., EAST OF KEDZIE]?
YES ..... 1 [SKIP TO R1]
NO ..... 2 [POLITELY END; DISP. #21]

FQR 60659:

S3A. Do you live between Kedzie Avenue and Lake Michigan [I.E., EAST OF KEDZIE]?
YES ..... 1
NO ..... 2 [POLITELY END; DISP. #21]
S3B. And, do you also live between Peterson Avenue and Evanston [I.E., NORTH OF PETERSON]?
YES ..... 1 [SKIP TO R1]
NO ..... 2 [POLITELY END; DISP. #21]

FQR 60660:

S4. Do you live between Peterson Avenue and Evanston [I.E., NORTH OF PETERSON]?
YES ..... 1 [SKIP TO R1]
NO ..... 2 [POLITELY END; DISP. #21]

R1. For this survey, I need to speak with the person in your household, 18 years of age or older, who had the last birthday [I.E. MOST RECENT BIRTHDAY]. (Would that be you?)

[PROCEED TO QUESTIONNAIRE ONCE SPEAKING TO ELIGIBLE RESPONDENT]

## RESULTS

There were 6,833 telephone numbers used in the RDD sampling, which led to 1,292 interviews, as opposed to 2,741 numbers used in the RVD sampling method, which led to 1,278 interviews. Thus, it took 2.5 times as many telephone numbers to accomplish the RDD part of the design as compared to the RVD portion. This equated to more than 10,000 additional dialings (i.e., call attempts) by interviewers to complete essentially the same number of RDD interviews as RVD interviews. If, on the average, an interviewer could make 15 dialings per hour that did not lead to completions, then the additional dialing necessary for the RDD sample took approximately 600 person hours. All costs associated with this extra work (wages, benefits, telephone equipment and units, etc.) exceeded \$10,000.

Across all nine areas, about 1 in 3 of the RDD numbers (33.1%) reached an eligible household, compared with 3 in 4 of the RVD numbers (74.8%). Even though the RVD telephone numbers were selected from the current Chicago reverse directory, 25% of the RVD numbers did not reach eligible households; these telephone numbers were either non-working or they no longer rang within the target area boundaries.

Among those telephone numbers that reached households, 9 in 10 of the RVD sample reached geographically eligible households (90.1%). In contrast, less than 3 in 5 of the RDD households reached were geographically eligible (55.8%); although this was a higher overall rate than had been estimated. Furthermore, there was variation across the nine areas in efficiency of reaching eligible households. The lowest efficiency among the RDD samples was 24% versus a low of 85% in the RVD samples.

Overall, the RDD samples had a slightly lower response rate from eligible households than the RVD samples; 57% versus 62%, respectively. In this context, nonresponse refers to refusals and to those households where the designated respondent was never reached. However, among those households in which the designated respondent was reached by the interviewer, there was very little difference between the two samples in cooperation rates (i.e., respondents reached and willing to participate); about 3 in 4 in both types of samples. In addition, the number of call attempts per completed interview did not differ significantly by sample type; for both samples, approximately 2/3 of the interviews were completed within three call attempts.

The two samples were compared on some quality-of-respondent-participation variables as measured by the interviewers after the completed interview. Although

the RDD respondents were rated by the interviewers as slightly more interested in the interview, no meaningful differences were found between the two samples on any of these measures.

Beyond comparative findings on the efficiency of the two samples to achieve completed interviews with eligible respondents, the data provided the opportunity to investigate any sample-type differences in the substantive measures that the survey gathered. In other words, how similar or dissimilar were the data gathered via each sampling method for the demographic variables and substantive dependent variables?

The two samples differed to a statistically significant degree on a number of demographic factors. However, in most cases, these differences were not large (or meaningful) in absolute size with the exception of Hispanic ancestry (see Table 1). Compared to the RVD sample, the RDD sample was younger, had fewer children, had lived in her/his neighborhood fewer years, was more likely to be male, Hispanic, a renter, and was less likely to be married, and to list her/his telephone number.

In terms of substantive differences between the two sample types (see Table 2), and considering the above noted demographic differences, it is not surprising to find that the RVD sample was more aware of neighborhood organizing efforts and was more positively disposed to police efforts in and interactions with their neighborhoods (i.e., since these respondents have lived in their neighborhoods longer they have longitudinal points of comparison and a greater likelihood of noticing police efforts and improvements).

The RDD sample reported more rapes/sexual assaults, truancy, drugs, car vandalism and graffiti than the RVD sample. Respondents in the RDD sample also differed from the RVD sample in their perception that their neighborhood will be worse off next year than it is now. These responses are consistent with the finding that households that do not list their telephone numbers have a greater fear of crime and, therefore, perceive that crimes occur more often and/or are more aware of the actual occurrence of crimes in their neighborhoods.

As noted, statistically significant differences were found for some substantive dependent variables by sample type. However, it is important to understand the relative proportion of the differences found.. In total, 83 dependent variables were included in this study. Of these 83 variables, 24 (29%) were found to significantly differ by sample type. The remaining 59 variables (71%) did not differ by sample type. That is, although there were some differences found for some dependent measures, the vast majority of these measures did not differ by sample type.

Table 1:

## Demographic Variables by Sample Type

Variable	Random-Digit Dialing	Reverse Directory	<i>p</i> <
% Female	63.1	58.0	.008
Average Year of Birth	1950	1945	.000
% Hispanic	14.6	7.4	.000
% African-American/Black	33.8	32.6	NS
% HS Grads, No College	27.5	27.2	NS
% Bachelors Degree	15.5	16.6	NS
% HSHLD Income < \$10,001	19.8	19.9	NS
% HSHLD Income > \$60,000	6.8	7.5	NS
% No Income Given	18.6	18.9	NS
% Married	34.0	39.6	.000
Average # Adults in HSHLD	2.2	2.2	NS
Average # Children in HSHLD	1.0	.8	.000
% Employed Full-Time	49.0	44.3	.000
% Retired	12.1	20.0	.000
% Home Owners	46.6	55.4	.000
Average # Yrs Lived in NBHD	12.4	14.6	.000
% 1 Telephone Number in HSHLD	81.0	83.1	NS
% Number Listed in Chicago Directory	54.1	88.5	.000

Table 2:

Attitudinal and Experiential Variables By Sample Type For Which Significant Differences Were Found

Variable	Random-Digit Dialing	Reverse Directory	<i>p</i> <
% Say NBHD Worse Than Last Year	40.1	35.2	.012
% Say NBHD Will Be Worse Next Year	32.5	26.6	.003
% Say Neighbors Go Own Way vs. Help	47.1	41.2	.005
% Say Will Live in NBHD Next Year	76.7	76.0	.001
% Say Public Drinking Big NBHD Problem	21.4	17.3	.023
% Say Graffiti Big NBHD Problem	21.8	22.7	.015
% Aware of Efforts to Organize NBHD	50.2	55.6	.020
% Say NBHD Crime Prevents Activities	46.7	42.7	.042
% Say Police Responsive to NBHD Needs	62.9	67.3	.025
% Say Police Work Well With NBHD	31.6	33.9	.015
% Say Police Doing Well Prevent NBHD Crime	35.6	37.9	.002
% Say Police Doing Well Keeping NBHD Order	44.9	47.0	.020
% Say Police Polite to NBHD Residents	59.4	63.7	.000
% Say Police Concerned With NBHD Problems	62.5	65.2	.024
% Say Police Helpful in NBHD	68.1	71.9	.006
% Say Police Fair in NBHD	63.3	66.6	.000
% Say Police Better in NBHD Than Last Yr	17.4	14.9	.006
% Saw Police Frisk Person in NBHD Last Month	36.1	31.5	.012
% Saw Police Talk to NBHD Resident Last Month	24.4	25.2	.048
% Say Big Problem With Truancy	23.2	19.7	.035
% Say Big Problem With Drugs in NBHD	38.7	32.8	.016
% Say Big Problem With Rape in NBHD	10.5	8.2	.000
% Say Car Vandalized in Past Year	20.8	16.4	.012
% Say Victim of Harmful Threat	9.6	6.5	.010

## DISCUSSION

The research presented here is preliminary in nature. Currently, there is little known about the data quality and cost differences between random-digit dialing and reverse directory sampling, especially in small area telephone surveys. This paper provides information gathered from one survey utilizing a dual-frame sampling approach. In addition, an attempt has been made to present a variety of factors needing consideration by researchers when weighing the benefits and costs of a particular sampling design.

It is obvious that cost is an important consideration when choosing the sampling method that will gather the most accurate data within finite resources. In the present case, the cost of generating the telephone numbers used in the RVD sample was about \$2,000 more expensive than the cost of generating the RDD telephone numbers -- despite the fact that 2.5 times as many numbers were required for the RDD design. The additional cost of the RVD sample is due to personnel time devoted to the manual labor required by the specific layout of addresses in these nine areas. The RVD portion of the sampling required a person to methodically sample telephone numbers by hand from the reverse directory on a street-by-street basis. In contrast, the computer was used to generate the RDD telephone numbers via a modified two-stage process.

When considering all expenses involved, we estimate that approximately 10% more interviews (about 250 more) could have been conducted for the same amount of money, if all of the telephone numbers had been generated via RVD sampling rather than using RDD for one-half of the design.

The findings presented in Table 2 indicate that there were statistically significant differences between the two sample types for some dependent measures. However, for the purposes of the present evaluation project, none of these differences was large enough to suggest that the public policy related conclusions would have been any different had all of the interviewing been based on RVD

sampling. Furthermore, for the vast majority of dependent measures, no significant differences were found. In other words, more interviewing could have been conducted with a slight reduction in sampling error, for the same amount of funds, with no basic changes in conclusions. This could not have been known by the principal investigators at the time a sampling design needed to be selected.

As previously mentioned, researchers need to make the best decisions possible while weighing many factors. Since those households that do not list their telephone numbers are more likely to be non-White and to have a greater fear of crime, and since this telephone survey was interviewing households in areas known to have non-White populations about crime in their neighborhoods, Coverage Error had been the primary concern when thinking about the RVD approach. On the other hand, limited funds were also a concern and the RDD approach is generally more costly when a lot of geographic screening is required for small area surveys. Hence, the dual-frame sampling approach was selected for this particular survey.

Every project and research agenda is unique. The same conclusions reached here might not have been drawn from another survey project with different geographic areas and different dependent measures. Therefore, additional methodological research is needed to determine what the similarities and differences are between these two sampling frames (random-digit dialing and reverse directory) as they affect survey quality and related policy recommendations before any broad generalizations should be made about them.

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